

A REVISION OF THE YELLOW BLOODWOODS (MYRTACEAE: *EUCALYPTUS* SER. *NAVICULARES* MAIDEN)

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Summary

Yellow bloodwoods, a well-known group now accepted as comprising 12 taxa of largely Queensland eucalypts, is revised. Five new species, *Eucalyptus scabrida*, *E. bunites*, *E. petalophylla*, *E. aureola* and *E. leptoloma* and two new subspecies *E. peltata* subsp. *dimorpha* and *E. watsoniana* subsp. *capillata* are described. The buds and fruits of each new taxon are illustrated where relevant and a key and distribution maps of all taxa are provided. The paper includes a summary of the five previously published species, notes on the classification of the series and comparisons in tabular form of all accepted bloodwood groups (informal *Eucalyptus* subgen. *Corymbia* Pryor & Johnson).

1. Bloodwoods

The bloodwoods are a natural and distinctive group of species in *Eucalyptus* occurring in all mainland States. They were given prominence by Bentham (1867) when he erected the *Eucalyptus* subseries *Corymbosae* based on a combination of characters concerning the inflorescence, fruit and seeds. The *Corymbosae* comprised 16 species in Bentham's treatment but subsequent research has resulted in the publication of at least 80 (Carr & Carr 1987). Furthermore, several natural groups within *Corymbosae* have been recognised (Blakely 1934 and subsequent authors).

Most of the species in the subseries or those published later and of obvious affinity are rough-barked, have winged seed¹, and belong to what are commonly called "red bloodwoods". A much smaller group (all rough-barked species) is the "yellow bloodwoods" which have unwinged seed², while there are three completely smooth-barked species, also with unwinged seed, viz *E. maculata* Hook., *E. henryi* Blake and *E. citriodora* Hook. Three other species have been variously placed in the red or the yellow bloodwoods or, in the case of two of them, *E. jacobsoniana* Blakely and *E. trachyphloia* F. Muell., in monotypic series (see later).

The species so far referred to are known collectively as the "woody-fruited bloodwoods". We dissociate them totally from the group known as the "paper-fruited bloodwoods". Blakely (1934) confused these two groups, but the taxonomic distinctions were discussed and clarified by Blake (1953) who erected two series to accommodate the groups, viz *Corymbosae*, based on Bentham's subseries and *Clavigerae*, based on an informal unranked taxon of Maiden (1923). Pryor and Johnson (1971) followed Blake in distinguishing them and equating their rank. They differed from Blake in their erection of informal subgenera (*Corymbia* and *Blakella* respectively) for the two groups in contrast to Blake's series which were largely accepted by Chippendale (1988). In this paper, we do not attend to the question of rank at these levels which is under consideration by others for the whole genus *Eucalyptus*, but treat the yellow bloodwoods as a series following Maiden (1920) and Chippendale (1988).

¹ The hyaline wing approximates the length of the body of the seed. We use the term "wing" purely descriptively with no functional implication.

² The seed of *E. leptoloma* may have a terminal appendage much shorter than the length of the body of the seed (see later).

2. Recognition of yellow bloodwoods as a distinctive group

a. General

Yellow bloodwoods are a relatively small group of species endemic to eastern Australia. They are trees usually recognisable in the field by their striking yellowish, flaky, rough bark, although they can be confused in this character with the related *E. trachyphloia* (an anomalous bloodwood, see later) and possibly with the quite unrelated *E. similis* Maiden, *E. phoenicea* F. Muell. and *E. cloeziana* F. Muell., all of which occur within or near to the geographic range of the yellow bloodwoods in Queensland.

b. Taxonomic history

The first species of the series to be formally described was *E. eximia* Schauer in 1843. This is understandable as this species is prominent in the hinterland of Sydney. All other species in the series are endemic to Queensland and were not discovered by botanists until many years later.

It is unlikely that Schauer was apprised of the field appearance of *E. eximia* and his description covers only leaves, inflorescence structure, and flowers. The inflorescence was given as a "terminal panicle".

The inflorescence, which is only pseudo-terminal (Johnson 1972), was the main character on which Benth. (1867) based his subseries *Corymbosae* in "Flora Australiensis". A similar inflorescence occurs in *Porantherae* Benth., but the author correctly distinguished the anther type in his series *Porantherae* from that of the series *Normales* Benth. where the *Corymbosae* were placed.

The second yellow bloodwood recognized, *E. peltata*, was published by Benth. (1867) in "Flora Australiensis", and was placed in *Corymbosae*. Mueller had communicated some information to Benth. about bark of *E. peltata* ("dark shining brittle and flaky but persistent") but there is still no bark information on *E. eximia* in "Flora Australiensis".

Benth. described seed characters when possible and reported the winged seed for most of the red bloodwoods, although the divergent seed form of *E. calophylla* R. Br. ex Lindley was pointed out. He correctly, though briefly, reported the seed form of *E. peltata* based on information from Mueller but seeds were not mentioned under *E. eximia*. Hence the natural affinity between the two species was not evident to him and they are widely separated in Benth.'s treatment.

Bark characters in eucalypts were given prominence some years earlier by Mueller (1858) in a somewhat facile classification in which he grouped some boxes and ironbarks with several bloodwoods, including *E. trachyphloia*, in an informal, unranked taxon, *Rhytiphloiae* (wrinkled bark). This may have been the reason for Benth.'s placement of this species in series *Porantherae* in "Flora Australiensis". Mueller's description of the bark in the protologue of *E. trachyphloia* as "frustuloso" (fragmented) is important as it draws attention to the tessellated nature of the bark of the species, which is also seen in most box (*Porantherae*) species. Apart from the anomaly of *E. trachyphloia*, Benth. was aware of a fundamental disparity between the boxes and the bloodwoods, i.e. the fundamentally different anthers, which resulted in his grouping them into different taxonomic series.

Mueller published a third yellow bloodwood, *E. watsoniana*, in 1876. The bark was described as "persistent, wrinkled and sometimes scaly, red-brownish", the inflorescences as "panicles terminal" and the seed as "winged"! (terminology from Maiden's translation 1920). Mueller referred to it as a "bloodwood" but there are no further clues to its affinity. Maiden (1920) correctly allied it (inasmuch as they are bloodwoods in the broad sense) with *E. maculata*, *E. eximia*, *E. corymbosa* Smith (syn. *E. gummifera* (Gaertner) Hochr.) and *E. abergiana* F. Muell., yet not with *E. peltata* which he treated in the previous few pages.

E. leichhardtii was published by F.M. Bailey in 1906 and the bark was given as "thick, spongy and somewhat lamellar ... light yellowish brown" - probably the most useful description of yellow bloodwood bark to that time. The inflorescence was given

as a "terminal panicle" and the seeds were adequately described. It is unfortunate that this species with the most informative description to date has been consistently downgraded, firstly as conspecific with *E. peltata* by Maiden (1920) then by Blakely (1934), and later as a subspecies of *E. peltata* by Johnson and Blaxell (1973). The subspecies status was followed by Chippendale (1988).

The most recently published yellow bloodwood is *E. bloxsomei* Maiden in 1925. Maiden called it a "bloodwood" and more specifically a "yellow jacket" or "yellow bloodwood". He gave no description of the seeds yet he clearly grew seedlings for his diagnosis. He related the species to *E. peltata* and *E. watsoniana* and paid particular attention in the protologue to the essential characters of the seedlings.

In addition to these species, we name seven new taxa in this study. While some of them were collected early this century, none was recognized as distinct until recent years. All of the new taxa are quite restricted in their distribution, and this factor has certainly delayed their discovery and/or recognition.

3. Various classifications

Blakely (1934) was the first botanist to segregate red bloodwoods (as subseries *Neocorymbosae* Blakely) from yellow bloodwoods, which name he gave in parentheses following the heading "xi Subseries *Ochrophloiae*". This latter subseries comprised *E. peltata*, *E. torelliana*, *E. eximia*, *E. bloxsomei*, *E. watsoniana*, and *E. jacobsiana*. The inclusion of *E. torelliana* was unqualified, while *E. jacobsiana*, with its stringy bark, was stated as having "no very close affinities in its Subseries". Blakely mentioned a similarity of *E. jacobsiana* with *E. trachyphloia*, which he placed unequivocally with the red bloodwoods while merely describing the bark as "rough, persistent throughout". The seeds of *E. trachyphloia* were described as "winged". Hence, inaccuracies and ambiguity resulted in a less than satisfactory classification, although we agree that all the species discussed so far are bloodwoods in the traditional senses. A significant contribution by Blakely was the segregation of *E. maculata* and *E. citriodora* in a third subseries (*Maculatae*). Their allied species, *E. henryi* was not published until 1977.

Blake (1953), in his treatment of "northern" Australian species, placed *E. trachyphloia* ("seed unwinged") and *E. jacobsiana* ("seed not winged") with the red bloodwoods and apparently associated them with *E. nesophila* Blakely which he incorrectly stated had seeds "not winged". In the conclusion to the section on *E. series Corymbosae*, he drew attention to the distinction ("unwinged seeds and some peltate leaves") within the series of yellow bloodwoods as well as the associated *E. subseries Maculatae* Blakely (*E. citriodora* and *E. maculata*) none of which was treated in this survey. It is curious with his attention to seed characters that Blake did not exclude *E. trachyphloia* and *E. jacobsiana* from the red bloodwoods.

Pryor and Johnson (1971) appear to follow Blakely rather than Blake in their informal treatment, although they improved Blakely's classification by the exclusion of *E. torelliana* and *E. jacobsiana* from "true" yellow bloodwoods.

In a recent informal classification of all the bloodwoods, Carr and Carr (1987) arranged the species in a manner little different from Pryor and Johnson's. The main modifications were their placement of *E. torelliana* in *E. series Maculatae* and they allied *E. jacobsiana* with *E. trachyphloia* in a separate series. Unlike Pryor and Johnson they diagnosed their supra-specific taxa.

Chippendale (1988), in his comprehensive treatment of the genus, formally erected monotypic series each for *E. jacobsiana*, *E. trachyphloia* and *E. torelliana*. He raised the *E. subseries Maculatae* to series rank, and accepted the established series *Terminaliptera* and *Naviculares* for the red and yellow bloodwoods respectively.

We accept Chippendale's assigning of species to the various series but we, in addition, define the essential morphology of the yellow bloodwoods and publish five new species and two new subspecies in the group. At this stage in our review we believe it is useful to summarise these diagnostic criteria of all the bloodwood groups in tabular (Table 1) and key form.

Table 1. Diagnostic characters of the bloodwood series

Series (after Chippendale, 1988)	bark	inflorescence (see series description)	outer operculum shed	seed (mature)	stigma**
<i>Terminaliptera</i> Maiden (red bloodwoods)	rough (tessellated) or smooth	"compound" pseudo-terminal	at flowering	terminally winged ("Terminalipterae") not winged ("Gummiferae")*	mop
<i>Trachyphloiae</i> Chippendale	rough (flaky)	"compound", pseudo-terminal	at flowering	not winged	mop
<i>Jacobsianae</i> Chippendale	rough (fibrous)	"compound", pseudo-terminal	at flowering	not winged	mop
<i>Naviculares</i> Maiden (yellow bloodwoods)	rough (flaky)	"compound", pseudo-terminal	during bud development	not winged	tapered
<i>Torellianae</i> Chippendale	Smooth (weakly tessellated at base)	"compound", pseudo-terminal	during bud development	not winged	mop-tapered
<i>Maculatae</i> (Blakely) Chippendale	smooth	"compound" axillary	near or at flowering	not winged	mop

* Comprising *E. calophylla* R. Br. ex Lindley, *E. gummifera* (Gaertner) Hochr. and *E. haematoxylon* Maiden.

** Terminology as in Boland & Sedgley (1986).

4. Key to the bloodwoods

1. Seed not winged or with appendage much shorter than body of seed, keeled on broad dorsal side, shiny red-brown 2
Seed with terminal wing approximately the length of body of seed, or if lacking terminal wing, ridged longitudinally and sometimes with rudimentary lateral wings; outer operculum persistent till flowering series **Terminaliptera**
2. Outer operculum persistent till flowering 3
Outer operculum shed before flowering 5
3. Bark smooth; inflorescences 3-flowered, arranged on axillary axes among upper leaves. series **Maculatae**
Bark rough; inflorescences 7-flowered, arranged in leafless terminal clusters 4
4. Bark fibrous series **Jacobsianae**
Bark flaky, tessellated series **Trachyphloiae**
5. Bark mostly smooth and green, with rough basal stocking; inflorescences 3-flowered series **Torellianae**
Bark flaky, yellowish, tessellated over whole trunk; inflorescences 7-or more-flowered series **Naviculares**

5. Yellow bloodwoods

Eucalyptus series **Naviculares** Maiden, Crit. Revis. *Eucalyptus* 7: 109 (1925); *E.* subser. *Corymbosae* Benth., Fl. austral. 3: 198 (1867) ex parte excl. type; *E.* subser. *Ochrophloiae* Blakely, Key *Eucalypts* 91 (1934). Type: *E. eximia* Schauer (lecto: *vide* Chippendale, Flora of Australia 19: 502 (1988)).

Trees mostly 5–15 m tall, occasionally to 22 m, forming a lignotuber. Bark loose and flaky, irregularly tessellated, persistent at least to small branches, golden-yellow, orange- or brownish yellow, weathering on the outside to pale brown. Cotyledons reniform. Seedling leaves petiolate, decussate and remaining opposite, discolorous, hairy (Fig. 1), peltate in some species. Juvenile leaves alternate, peltate in most species, sometimes persisting in the mature crown. Adult leaves formed in most species, petiolate, alternate, lanceolate or falcate, bright green or grey-green, shiny or dull, concolorous, rarely discolorous, glabrous; side veins pinnate at relatively wide angle, terminating in distinct intramarginal vein; reticulation dense, oil glands numerous, small, one per areole. Unit inflorescences arranged decussately on leafless ends of branchlets whose terminal leaf bud aborts (pseudo-terminal, apparently compound inflorescence), usually 7-flowered, sometimes to 13-flowered, rarely to 21-flowered. Buds ovoid to clavate, smooth when fresh, but often ribbed or striate when dry, sessile or shortly pedicellate; outer operculum shed during bud development, inner operculum finally conical, apiculate or rostrate, sometimes broader than hypanthium, often with strong rubbery cuticle. Stamens white or creamy, inflexed in unopened bud; anthers cuboid/cuneate, dorsi-fixed, versatile, opening by longitudinal slits. Ovary sunk well below rim of hypanthium, (2 or) 3 (or 4)-locular. Style tip usually inserted into pit on underside of operculum or invested by irregular descending tube of tissue; stigma tapered. Ovules in (3–) 4–8 (–10) vertical rows (Fig. 2), with apparent incipient wing on upper side. Ovary chamber with rubbery membrane enveloping whole ovule contents on placenta (Fig. 3). Fruits woody, spherical-truncate, ovoid or urceolate, smooth when fresh, but often ribbed or striate when dry, 8–32 mm long; valves (2 or) 3 (or 4), enclosed; disc broad, descending. Seeds brown, elliptical, lustrous, wingless or with hyaline terminal appendage much shorter than body of seed, many keeled on dorsal side.

The series comprises 12 taxa, 11 of which are endemic to Queensland and one to New South Wales.

Habitat and geographical distribution

All yellow bloodwoods grow on sandy soils which may vary from very shallow to more than a metre deep. Most often, the parent material is sandstone while granite is also common. Rarely, trachyte provides the parent material.

Red bloodwoods also show a preference for sandy soils, but a small proportion of these species is adapted to heavier soils including alkaline clays and soils with poor drainage.

Yellow bloodwoods are distributed on the central coast and nearby ranges of New South Wales, and throughout much of sub-coastal Queensland, often in the vicinity of the Great Dividing Range. These areas experience only a few light frosts each year, or are frost-free.

Annual rainfall varies greatly from a possible excess of 2000 mm experienced by *E. leptoloma* near Paluma in northern Queensland, to a mere 500 mm for *E. leichhardtii* east of Barcaldine in central Queensland.

Ovule patterns in yellow bloodwoods

Apart from bloodwoods, the ovules in eucalypts are arranged on the placenta in an even number of easily-recognized vertical rows. Bilateral symmetry is the pattern, except for some vertical displacement of the ovules in one vertical row to "mesh" with those of a contiguous row (see ovule pattern in *E. pauciflora* in Boland *et al.* 1980). In contrast, this bilateral symmetry is not always seen in both the red and yellow bloodwoods. The ovules in bloodwoods are borne in 3 (rarely), 4, 5, 6, 7 or 8 (rarely 10) vertical rows and there is a rough association between bud size and number of rows. For example, both *E. ptychocarpa* and *E. watsoniana*, the largest-budded species in the red and yellow

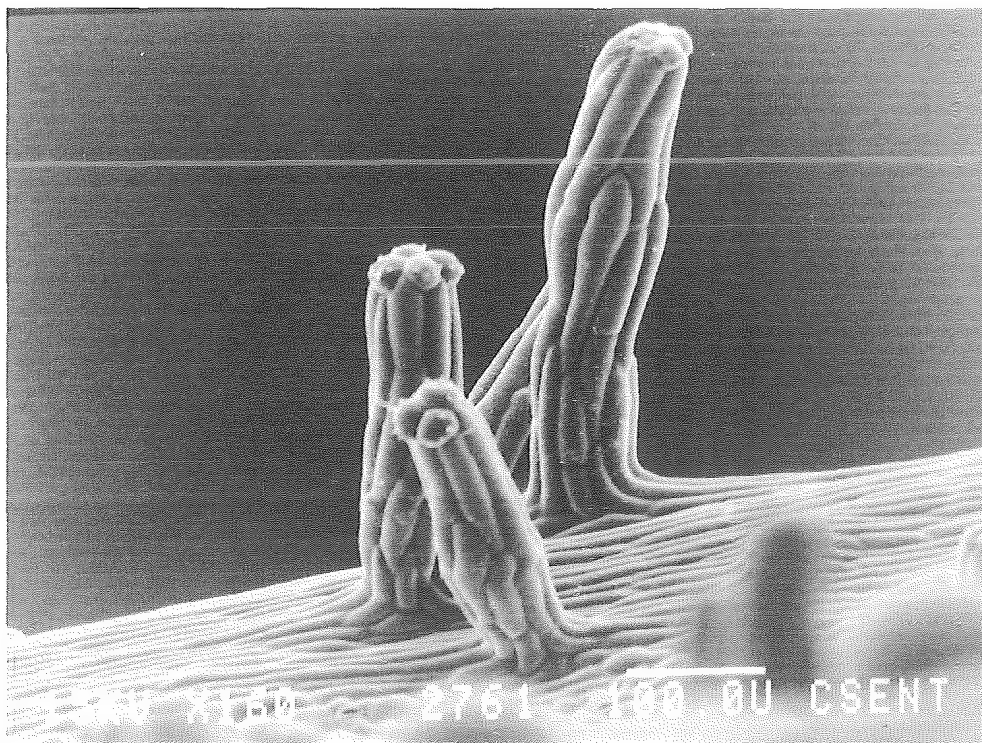


Fig. 1. Trichomes (bristle glands) on juvenile leaves of *E. scabrida* $\times 160$ (seedling of Brooker 4891). These are emergent oil glands with 4 cap cells bearing distinctive papillae (typical of bloodwoods and *Angophora*, Ladiges 1984).

bloodwoods respectively, have up to 8 (rarely 10) rows. Three-rowed placenta have been seen in *E. bunites*, which has the smallest buds of the yellow bloodwoods.

When the row number is odd, the middle row occupies the median vertical line on the placenta, thereby maintaining symmetry. When the number is even, one of the two middle rows occupies the median vertical line and bilateral symmetry is then lost. The ovules of the middle row become keeled (Fig. 2), suggesting that pressure causes some distortion during maturation and this character is carried on the mature seedcoat.

The number of rows can vary within a bud and certainly between buds from the same tree. The odd number of vertical rows and the asymmetry in the even-rowed examples appear to be distinctive features of the bloodwoods as it has not been reported elsewhere in the genus.

Juvenile leaves in yellow bloodwoods

There are few *Eucalyptus* series or subseries for which comprehensive seedling studies have been published. Recent examples are the results from investigations of the peppermints (informal *Eucalyptus* subseries *Amygdalininae* by Ladiges *et al.*, 1983), the informal series *Ovatae* (Ladiges *et al.*, 1984), the informal series *Capitellatae* (Ladiges *et al.*, 1986) and the green ashes (Ladiges *et al.*, 1988).

In the *Ovatae* study, the authors refer to the taxonomic problem provided by the similarities in adult plants of related taxa through "continuously varying shape factors". They contrasted this with the much greater dissimilarities occurring in the seedlings of the same species and stated that "the early stages of development are under intense selection pressures and that seedling characters may be the best indicators of evolutionary

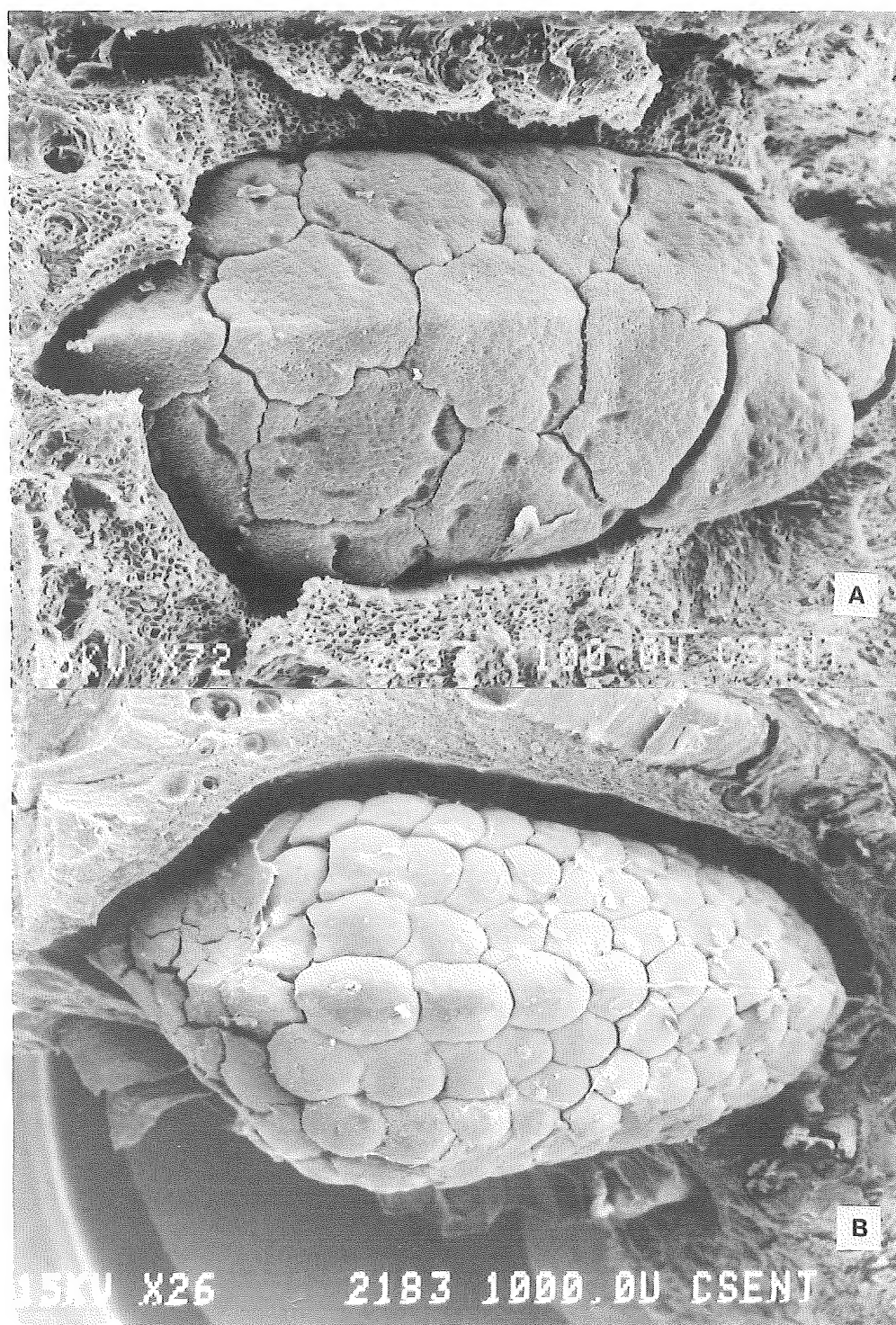


Fig. 2. Ovule patterns in the yellow bloodwoods. A. *E. bunites* $\times 72$. B. *E. watsoniana* subsp. *watsoniana* $\times 26$. A, Boland 1585; B, Brooker 4801.



Fig. 3. Rubbery membrane enveloping placenta and ovules in *E. petalophylla* $\times 48$ (A.R. Bean s.n.).

divergence in ... long-lived ... species". Ladiges *et al.* (1984) cited the advantage of discrete states in assessing a seedling and these are provided in more abundance in the juvenile plant than in the adult. In addition, an advantage in the assessment of glasshouse-grown seedlings is provided by the direct comparisons, node for node, that can be made between taxa.

These aspects of comparative morphology have been notably demonstrated by the yellow bloodwoods. Characters similar to those used by Ladiges *et al.* for their four groups have been seen in the yellow bloodwoods, with the addition of a further distinctive character, peltation in the seedling and juvenile leaves. The presence or absence of peltation and its persistence among only 12 taxa have provided instantly recognizable plant forms such that many of the taxa can be identified from the seedling alone. It is rare for individual species within series to be so distinctive in the juvenile stage as they are in the yellow bloodwoods. Consequently we emphasize the juvenile characters in the species descriptions.

6. Key to species and subspecies of *Eucalyptus* series *Naviculares*

- | | |
|--|---|
| 1. Crown of mature tree with at least some peltate, scabrid leaves | 2 |
| Crown of mature tree composed entirely of smooth, non-peltate leaves | 5 |
| 2. Crown comprising both smooth adult leaves and scabrid juvenile leaves | 3 |
| All of crown comprising scabrid juvenile leaves | 4 |
| 3. Operculum broader than hypanthium, fruits >19 mm long | |
| 8. <i>E. watsoniana</i> subsp. <i>capillata</i> | |
| Operculum same width as hypanthium, fruits 11–14 mm long | |
| 3. <i>E. peltata</i> subsp. <i>dimorpha</i> | |

4. Leaves broadly ovate to orbicular, 6–9 cm wide, petioles >15 mm long 1. *E. peltata* subsp. *peltata*
 Leaves narrowly ovate, 2–4 cm wide, petioles <15 mm long 2. *E. scabrida*
5. Adult and juvenile leaves green, moderately glossy 6
 Adult and juvenile leaves grey-green, dull 9
6. Adult leaves distinctly discolorous 12. *E. leptoloma*
 Adult leaves concolorous 7
7. Fruits <12 mm long 5. *E. bunites*
 Fruits >12 mm long 8
8. Trees growing on skeletal sandstone hills; buds often glaucous; pedicels
 0–2 mm long 11. *E. aureola*
 Trees growing in deep sand on flats and gentle rises; buds never glaucous;
 pedicels 3–6 mm long 10. *E. bloxsomei*
9. Fruits >19 mm long, operculum broader than hypanthium 10
 Fruits <19 mm long, operculum same width as hypanthium 11
10. Juvenile leaves glabrous, non-peltate or <3 pairs peltate
 7. *E. watsoniana* subsp. *watsoniana*
 Juvenile leaves hairy, >5 pairs markedly peltate
 8. *E. watsoniana* subsp. *capillata*
11. Seedling with peltate leaves for >10 nodes 12
 Seedling with <3 nodes of, or no peltate leaves 13
12. Adult leaves markedly falcate; fruits 14–18 mm long; NSW only 6. *E. eximia*
 Adult leaves not falcate; fruits 9–15 mm long; Qld only 4. *E. leichhardtii*
13. Adult leaves <25 mm wide with petioles 10–20 mm long; juvenile leaves
 narrowly lanceolate 5. *E. bunites*
 Adult leaves 25–40 mm wide with petioles 20–38 mm long; juvenile
 leaves broadly lanceolate 9. *E. petalophylla*

7. Digests of species*

1. *Eucalyptus peltata* Benth. Fl. austral. 3: 254 (1867). Type: Newcastle Range, Qld., October 1856, F. Mueller (holo: K; iso: MEL,NSW).

Eucalyptus peltata Benth. subsp. *peltata*

Small, often gnarled tree, to 7 m high, with golden-yellow rough bark, persistent on trunk and larger branches. Small and medium-sized branches smooth. Seedling leaves remaining opposite for four or five pairs, elliptical. Subsequent leaves alternate, markedly peltate, ovate, bluntly pointed, to 21 × 12 cm. Stems, petioles and laminae very hairy throughout. Leaves on mature trees alternate, peltate, ovate, to 11 × 8 cm, hairy; apex obtuse, mucronate. Petioles to 24 mm long. Peduncles terete or angular, to 20 mm long. Unit inflorescences 7-flowered. Pedicels 0–2 mm long. Buds to 8 × 6 mm; hypanthium glaucous. Fruits ovoid to truncate-spherical, 9–11 × 9–10 mm. Fig. 4A & B.

* denotes seedlings of parent trees grown and studied in glasshouse at CSIRO, Canberra, supplementing field observations

Selected specimens. Queensland. COOK DISTRICT: Newcastle Range, Feb 1928, *Brass* 1774 (CANB); Oak Park, 125 miles [201 km] N of Hughenden, Sep 1937, *Brass & White* 83, (BRI); Conjuboy to Hughenden, Aug 1973, *Brooker* 4139* (CANB). NORTH KENNEDY DISTRICT: Homestead, Oct 1935, *Blake* 9983 (BRI,CANB); 1 mile [1.6 km] N of Hospital Creek, 129 miles [208 km] N of Pentland, Sep 1970, *Turnbull* 44 (CANB); 30 km east of Pentland, Sep 1977, *Blaxell* 1544 & *Armstrong* (CANB,NSW); 14.3 miles [22.9 km] E of Pentland, Aug 1973, *Brooker* 4149 (BRI,CANB,K,NSW); Homestead Creek, 48 miles [76.8 km] W of Charters Towers, Jul 1964, *Larsen* s.n. (CANB); 64 km W of Charters Towers, Dec 1982, *Brooker* 7847* (BRI,CANB).

Distribution and habitat: *E. peltata* subsp. *peltata* is restricted to northern Queensland from Newcastle Range in the north to south of Homestead (Map 1). It grows on sandstone ridges in shallow sandy soils. It is associated with *E. setosa* Schauer, *E. melanophloia* F. Muell. and *E. persistens* L. Johnson & K. Hill.

Flowering period: January – February.

Notes: *E. peltata* subsp. *peltata* could be confused with *E. similis*, which has similar bark, where the two species overlap in their natural distributions but the crown of juvenile leaves in *E. peltata* subsp. *peltata* is immediately distinctive. Rarely do the ultimate shoots produce a short phase of glabrous intermediate leaves and such ontogenetic development is always arrested. The crown in subsp. *peltata* is almost wholly juvenile, while in subsp. *dimorpha* a mixture of adult, intermediate and juvenile leaves is present. The crown of *E. scabrada* also comprises only juvenile leaves but these are narrower than those in *E. peltata* subsp. *peltata*. In addition, *E. scabrada* is an erect tree compared with the gnarled habit of *E. peltata* subsp. *peltata* and has non-glaucous buds.

2. ***Eucalyptus peltata* subsp. *dimorpha* Brooker & A. Bean, subsp. nov. *Eucalypto peltata***
 Benth. subsp. *peltata* praesentia consistenti foliorum lanceolatorum et peltatorum et non peltatorum in arbore summa, fructibus majoribus, forma arboris superiore et distributione dissimili differt. **Typus:** Queensland. NORTH KENNEDY DISTRICT: 2.2 km N of railway between Laroona and Ewan, 19 May 1989, *M.I.H. Brooker* 10196* (holo: BRI; iso: CANB,DNA,MEL,NSW).

Tree to 12 m high, usually with erect trunk; bark orangy yellow to orange, persistent except on small branches. Seedling leaves remaining opposite for about five pairs, elliptical. Subsequent leaves alternate, concolorous, markedly peltate, ovate, apex rounded, to 16 × 10 cm. Stems, petioles and leaves very hairy throughout. Leaves on mature trees dull grey-green, concolorous, with both hairy, slightly peltate, and glabrous, non-peltate, lanceolate, acuminate forms, 11–17 × 3–6.1 cm. Petioles terete or flattened, 20–25 mm long. Peduncles 11–25 mm long. Unit inflorescences 7-flowered, rarely more. Pedicels 1–2 mm long. Buds glaucous, to 9 × 6 mm. Operculum low hemispherical. Fruits ovoid to cylindrical, or sometimes slightly urceolate, 12–15 × 10–11 mm. **Fig. 4C & D.**

Specimens examined. Queensland. NORTH KENNEDY DISTRICT: 14.4 km N of "Dotswood", W of Townsville, Jun 1989, *Bean* 1053 (BRI); Ewan–"Laroona" road, just S of Granite Creek, Jun 1989, *Bean* 1061 (BRI); 1 km S of Plumtree Creek on Charters Towers–Clarke R. Road, Sep 1977, *Blaxell* 1556 & *Armstrong* (BRI,NSW); 26 miles [41 km] SW of Mt Garnet, Sep 1937, *Brass & White* 115 (BRI); Tabletop Road, Hervey Range, May 1985, *Brooker* 8994 (BRI,CANB,NSW); 33.3 km from Bruce Highway on tableland at Tabletop, May 1989, *Brooker* 10208* (BRI,CANB,NSW).

Distribution and habitat: The main populations of this subspecies lie west of Townsville in north Queensland along the Herveys Range Development Road, but there are scattered stands further north and west (Map 1). This subspecies occurs in coarse white sandy soil derived from granite. The major associated species are *E. xanthoclada* Brooker & A. Bean, *E. shirleyi* Maiden and *E. crebra* F. Muell.

Flowering period: Unknown.

Etymology: From the Greek *di*, two and *morphe*, form, in reference to the composition of the mature leafy crowns.

Notes: *E. peltata* subsp. *dimorpha* can be distinguished in the field by the large leafy crown comprising a mixture of juvenile, intermediate and adult leaves.

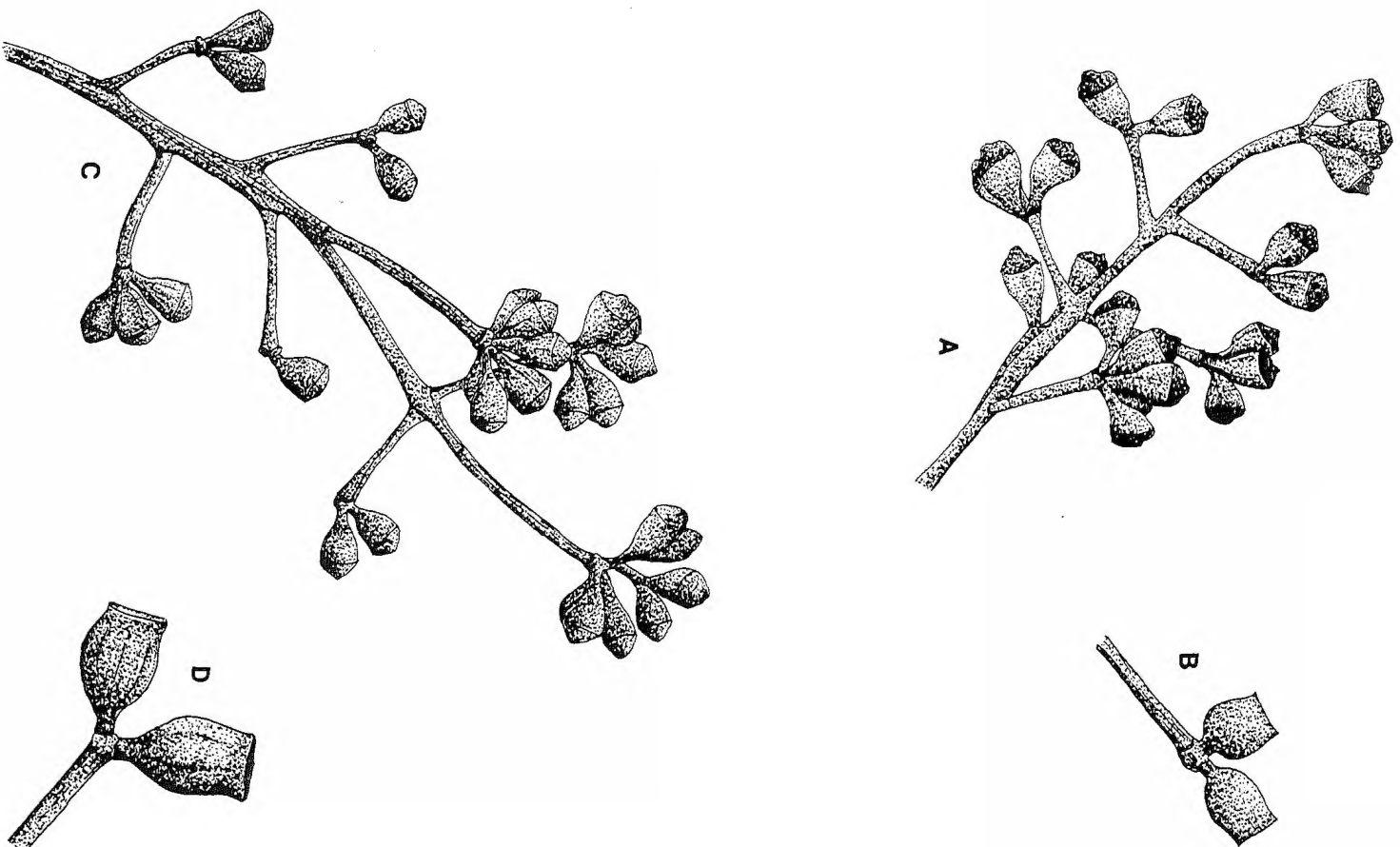


Fig. 4. *E. pelata* subsp. *pelata*: A, buds $\times 1$. B, fruits $\times 1$. *E. pelata* subsp. *dimorpha*: C, buds $\times 1$. D, fruit $\times 1$. A, Brooker 7847; B, Blake 9983; C, D, Brooker 10196.

3. *Eucalyptus scabrida* Brooker and A. Bean, sp. nov. *Eucalypto peltata* Benth. affinis a qua foliis totis angustioribus, petiolis brevioribus, alabastris glaucedinem deficientibus et fructibus leviter parvioribus differt. **Typus:** Queensland. LEICHHARDT DISTRICT: 12.5 km from "Mantuan Downs" turn-off towards Springsure on Dawson Developmental Road, 14 October 1987, *M.I.H. Brooker* 9778* (holo: BRI; iso: CANB,MEL,NSW).

Tree to 10 m tall, bark yellow or orangy, persistent to smaller branches. Seedling leaves remaining opposite for six pairs, elliptical to ovate, non-peltate; stems, petioles and laminae densely hairy. Subsequent leaves alternate, distinctly peltate, hairy, ovate to lanceolate, apex acute, to 18 × 6 cm, slightly discoloured; petioles to 20 mm long. Leaves on mature trees grey-green, scabrid, peltate, ovate to lanceolate, to 11 × 3.5 cm, concolorous. Petioles almost terete, grooved, to 13 mm long. Peduncles angular, to 24 mm long. Unit inflorescences 7-flowered. Pedicels 1–2 mm long. Buds clavate, non-glaucous, to 9 × 6 mm; operculum low hemispherical, sometimes umbonate. Fruits ovoid to spherical-truncate or urceolate, to 12 × 10 mm. **Figs 1, 5A & B.**

Specimens examined. Queensland. LEICHHARDT DISTRICT: On Tambo road, 80.9 km W of Springsure, Aug 1984, *Bean* 93 (BRI); 80 km from Springsure towards "Tanderra", May 1986, *Bean* 448 (BRI,CANB); 10.8 miles [18 km] from Nandowrie towards Nardoo, Apr 1975, *Brooker* 4891* (BRI,CANB,MEL,NSW); 12.5 km from "Mantuan Downs" turn-off towards Springsure on Dawson Developmental Road, Oct 1987, *Brooker*, 9779, 9780 (CANB); 10.4 km E of "Mantuan Downs" turn-off on the Tambo to Springsure road, Sep 1974, *Kleinig* 194, 196, 197 (CANB).

Distribution and habitat: *E. scabrida* has a restricted distribution in central Queensland, the largest population being near Mantuan Downs station, west of Springsure (**Map 1**). It grows on sandstone ridges in shallow sandy soil. Associated species include *E. melanophloia* F. Muell., *E. dolichocarpa* D. Carr & S. Carr and *Angophora leiocarpa* (L. Johnson ex Leach) Thiele & Ladiges.

Flowering period: October.

Etymology: From the Latin *scabridus*, somewhat scabrous, in reference to the leaves at all stages.

Notes: *E. scabrida* has been confused with *E. peltata* subsp. *peltata* but can be distinguished by the erect habit, narrower leaves of the mature crown, shorter petioles and its non-glaucous buds.

4. *Eucalyptus leichhardtii* Bailey, Qld. Agric. J. 16:493 (1906); *E. peltata* subsp. *leichhardtii* (Bailey) L. Johnson & D. Blaxell, Contrib. N.S.W. Nat. Herb. 4: 453 (1973). **Type:** Queensland, near Alice, Central Railway, December 1905, *W. Pagan* s.n. (holo: BRI; iso: K,MEL,NSW).

Tree, 5–15 m high, with golden or orangy yellow bark, persistent on trunk and most branches. Seedling leaves remaining opposite for three pairs, elliptical, hairy, non-peltate. Subsequent leaves hairy, alternate, discoloured, peltate; leaf bases obtuse; apices at first rounded, later distinctly acute. Juvenile leaves peltate, acute, grey-green, slightly discoloured, hairy, ovate to deltoid, to 14.2 × 7.2 cm, becoming broadly lanceolate, to 21 × 6 cm; petioles and stems also hairy. Adult leaves lanceolate or narrowly lanceolate, to 19 × 3.8 cm, grey-green, concolorous; petioles 12–26 mm long, flattened. Peduncles to 18 mm long. Unit inflorescences 7-flowered. Pedicels 0–2 mm long. Buds 9–11 × 6–7 mm, hypanthium often glaucous, especially in northern Queensland. Operculum low hemispheric, umbonate. Fruits ovoid to urceolate, 9–15 × 8–13 mm. **Figs. 5C & D, 6.**

Selected specimens. Queensland. COOK DISTRICT: Mt Mulligan, Apr 1987, *Clarkson* 6916 (BRI,CANB,MBA,MEL,NSW,QRS); Mutchilba-Stannary Hills road, May 1971, *Hyland* 5072 (CANB,QRS); 2 miles [3.2 km] west of Lappa, Aug 1966, *Larsen* 606 (CANB); Watsonville-Bakerville road, Oct 1971, *Hyland* 5586 (BRI,CANB); between Watsonville and Bakerville, Jan 1972, *Brooker* 3355 (BRI,CANB,DNA,NSW,QRS); c. 1 km N of Chinaman Creek crossing on Watsonville road, Oct 1979, *Brooker* 6518, 6519* (CANB). NORTH KENNEDY DISTRICT: 7.4 miles [11.8 km] S of Mt Garnet, Nov 1971, *Kleinig* 1*, 3 (CANB); Mt Claro, W of Ingham, Jun 1966, *Walker* ANU366 (CANB); range before Hidden Valley, 19.8 km W of Paluma, May 1989, *Brooker* 10205* (BRI,CANB,DNA,MEL,NSW); 60 km N of Pentland to Wando Vale, Sep 1977, *Blaxell* 1554 & *Armstrong* (CANB,NSW); White Mountains, Torrens Creek catchment, May 1985, *Brooker* 8973 (CANB). SOUTH KENNEDY DISTRICT: c.22 km NNW of Yarrowmere Station, Oct 1983, *Henderson* 2861 (BRI,CANB); near junction of Bowen and Burdekin Rivers, Oct 1958, *Blake* 18691 (BRI,CANB); 32 km W of Alpha, May 1989, *Brooker* 10217*, 10218 (BRI,CANB,DNA,NSW). MITCHELL DISTRICT: Capricorn Highway, 3 km E of Alice Railway Siding, Jul 1989, *Bean* 1095 (BRI). LEICHHARDT DISTRICT: 47.4 km from Clermont towards Alpha, May 1989, *Brooker* 10214* (BRI,CANB,DNA,NSW); 26.5 km W of Springsure on Tambo road, Oct 1987, *Brooker* 9782* (CANB); Salvator Rosa NP, 170 km SW of Springsure, Sep 1987, *Thomas* 242 (BRI).

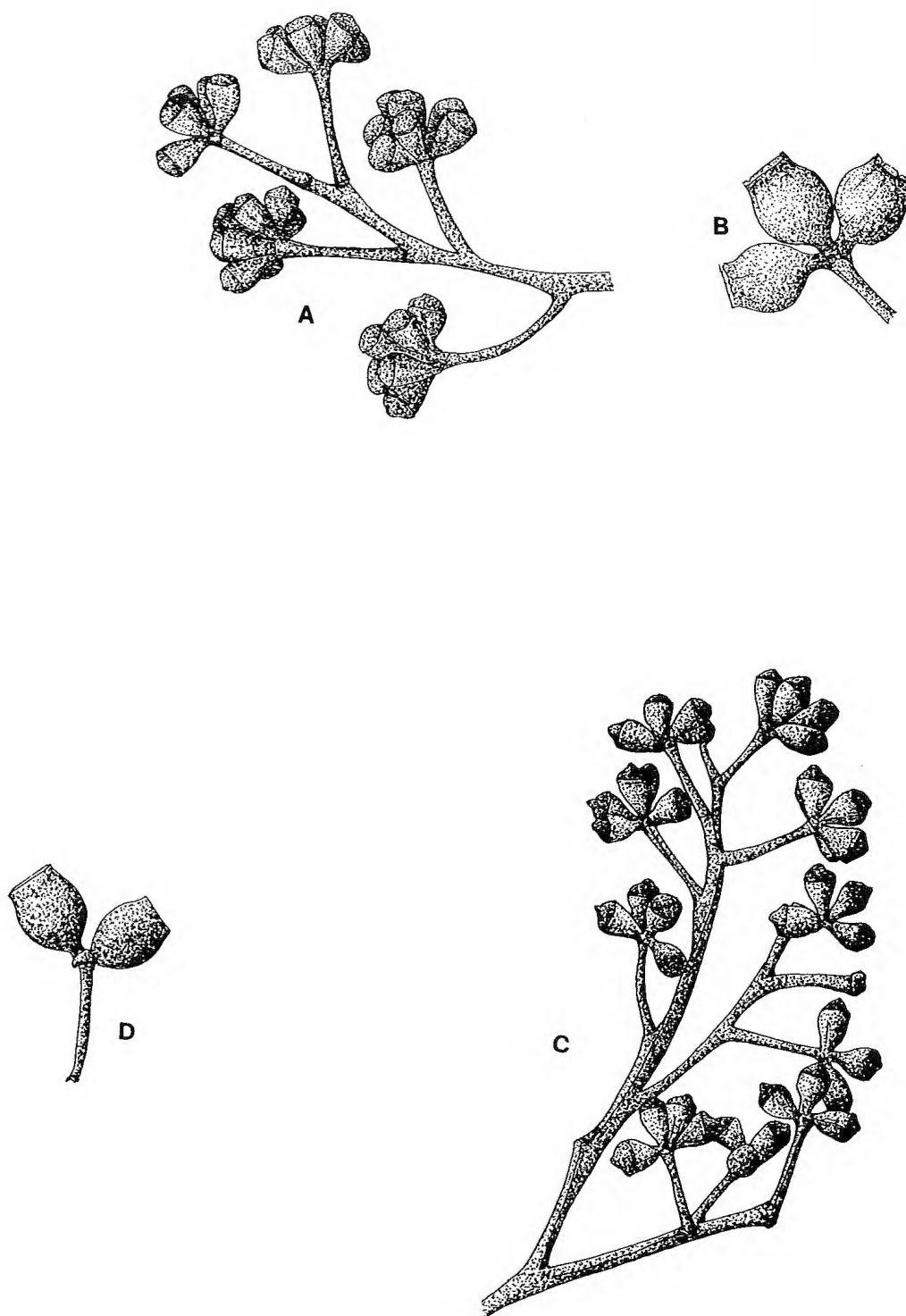


Fig. 5. *E. scabrida*: A. buds $\times 1$. B. fruits $\times 1$. *E. leichhardtii*: C. buds $\times 1$. D. fruit $\times 1$. A,B, Brooker 9778; C, Hyland 5586; D, Kleinig 3.



Fig. 6. *E. leichhardtii*: from seedling of Brooker 10217 $\times 0.4$.

Distribution and habitat: This species is distributed sporadically over a wide area of central and northern Queensland, ranging from Salvator Rosa National Park to Mt Mulligan (Map 1). It grows on sandstone ridges and hills, or on sandy soils over sandstone. There are many eucalypt species associated with *E. leichhardtii* throughout its range including *E. citriodora* Hook. and *E. brachycarpa* D. Carr & S. Carr.

Flowering period: January – March.

Notes: *E. leichhardtii* is a distinctive species, and no closer to *E. peltata* subsp. *peltata* with which it has frequently been associated taxonomically than to other species, e.g. *E. aureola*. In its fragmented distribution it is not sympatric with *E. peltata* subsp. *peltata*.

5. *Eucalyptus bunites* Brooker & A. Bean, sp. nov. *Eucalypto leichhardtii* Bailey affinis a qua foliis plantularum angustis non peltatis, foliis adultis saepe angustioribus, hypanthiis glaucadinem deficientibus et fructibus saepe subsphaericis differt. **Typus:** Queensland, LEICHHARDT DISTRICT: Blackdown Tableland, Queensland, 31 August 1972, M.I.H. Brooker 3779* (holo: BRI; iso: CANB,K,MEL,NSW).

Tree with erect trunk, 5–18 m high. Bark orangy to orangy-brown, persistent except on smallest branches. Seedling leaves remaining opposite for about six pairs, elliptical to lanceolate, to 8.5×2.7 cm. Stems, petioles and laminae hispid. Juvenile leaves alternate, lanceolate to narrowly lanceolate, never peltate, bright green (northern population) or grey-green (southern population), to 22×5 cm, slightly discolorous; apex acute to acuminate. Stems, petioles and laminae glabrous. Adult leaves narrowly lanceolate or falcate, to 15.0×2.5 cm, concolorous, acuminate; green and slightly glossy in northern population, dull grey-green in southern population. Petioles 10–20 mm long, distinctly flattened, up to 2 mm wide. Peduncles angular, to 20 mm long. Unit inflorescences 7-flowered. Pedicels 1–2 mm long. Buds clavate, to 7×5 mm. Operculum low hemispheric, umbonate. Hypanthium not glaucous. Fruits truncate-spherical, sometimes ovoid, 9–12 \times 9–11 mm. **Figs 2A, 7 & 8.**

Specimens examined. Queensland, LEICHHARDT DISTRICT: 1 km along Oilbore road, towards Robinson Gorge, Sep 1985, *Bean* 275 (BRI,NSW); Blackdown Tableland, 21.4 km in from Umolo railway siding, Apr 1979, *Boland* 1585* (CANB); Blackdown Tableland, gate, Sep 1972, *Brooker* 3782 (BRI,CANB,K); 0.4 km S of gate to Blackdown Tableland, Apr 1975, *Brooker* 4814 (AD,BRI,CANB,MEL,NSW); 61 miles [100 km] south of Bauhinia Downs towards Taroom, Apr 1975, *Brooker* 4839* (AD,BRI,CANB,MEL,NSW); northern slope of Blackdown Tableland, on entrance road, Mar 1982, *Brooker* 7375* (BRI,CANB,NSW); road to Stony Falls, Blackdown Tableland, Mar 1982, *Brooker* 7382* (BRI,CANB,NSW); NW of Horseshoe Lookout, Blackdown Tableland, Mar 1982, *Brooker* 7386 (BRI,CANB,NSW); approach to Blackdown Tableland, May 1989, *Brooker* 10224 (BRI,CANB,DNA,NSW); Blackdown Tableland, track to east opposite Loop road, Mar 1990, *Brooker* 10453* (BRI,CANB,MEL,NSW); at gate to Blackdown Tableland S.F., Sep 1974; *Chippendale* 1110, 1112 (AD,BRI,CANB,MEL,NSW,PERTH); Blackdown Tableland, Apr 1973, *Cossalter* 627 (CANB); 32 miles SW of Duaringa, Aug 1970, *Turnbull* 12 (CANB).

Distribution and habitat: *E. bunites* has a restricted distribution in central Queensland (**Map 3**). It is best known from the Blackdown Tableland, and most collections have been made from there but it also grows in the Robinson Gorge area, about 150 km further south. It occurs on sandstone hills and ridges in shallow sandy soil. Associated species include *E. sphaerocarpa* L. Johnson & Blaxell, *E. baileyana* F. Muell., *E. sp. aff. E. umbra* R. Baker and *Angophora leiocarpa* (Johnson ex Leach) Thiele & Ladiges.

Flowering period: July – September.

Etymology: From the Latined Greek *bounites*, hill dweller, in reference to the common habitat for the species.

Notes: *E. bunites* has been collected on the Blackdown Tableland for some years but its identity has been confused, often being attributed to *E. leichhardtii*. Seedling trials revealed a taxon unlike any other in the series because of its long, narrow, non-peltate seedling and juvenile leaves. Its distribution is disjunct with the forms at the two sites showing juvenile leaf differences as shown above.

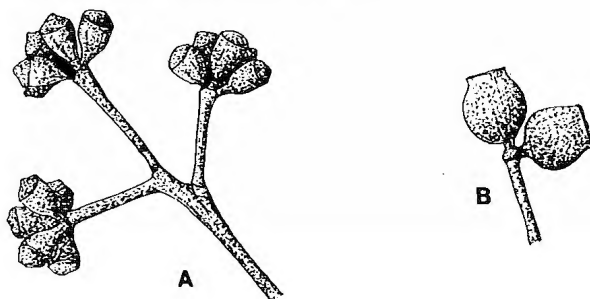


Fig. 7. *E. bunites*: A. buds $\times 1$. B. fruit $\times 1$. A, Brooker 7386; B, Brooker 3782.

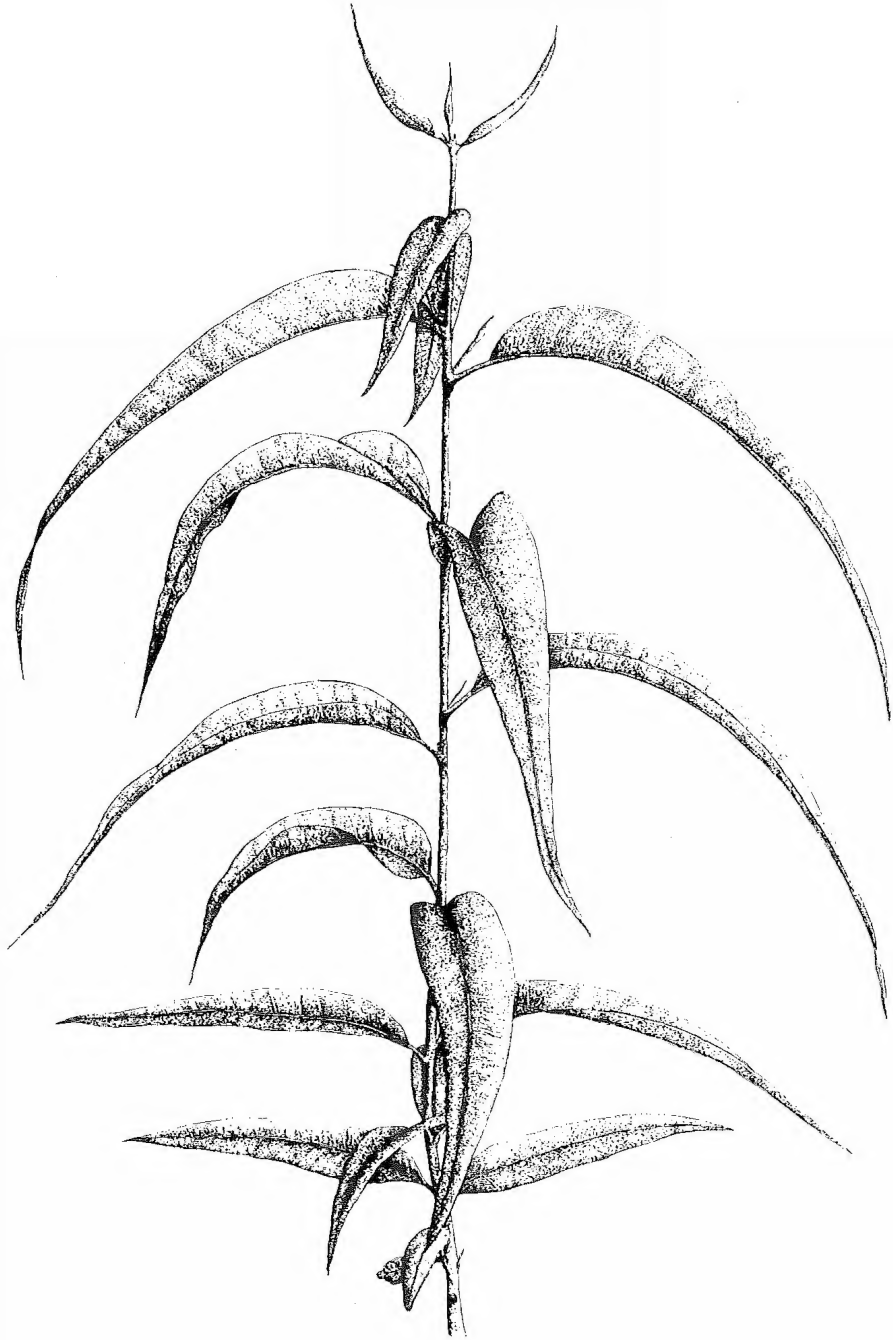
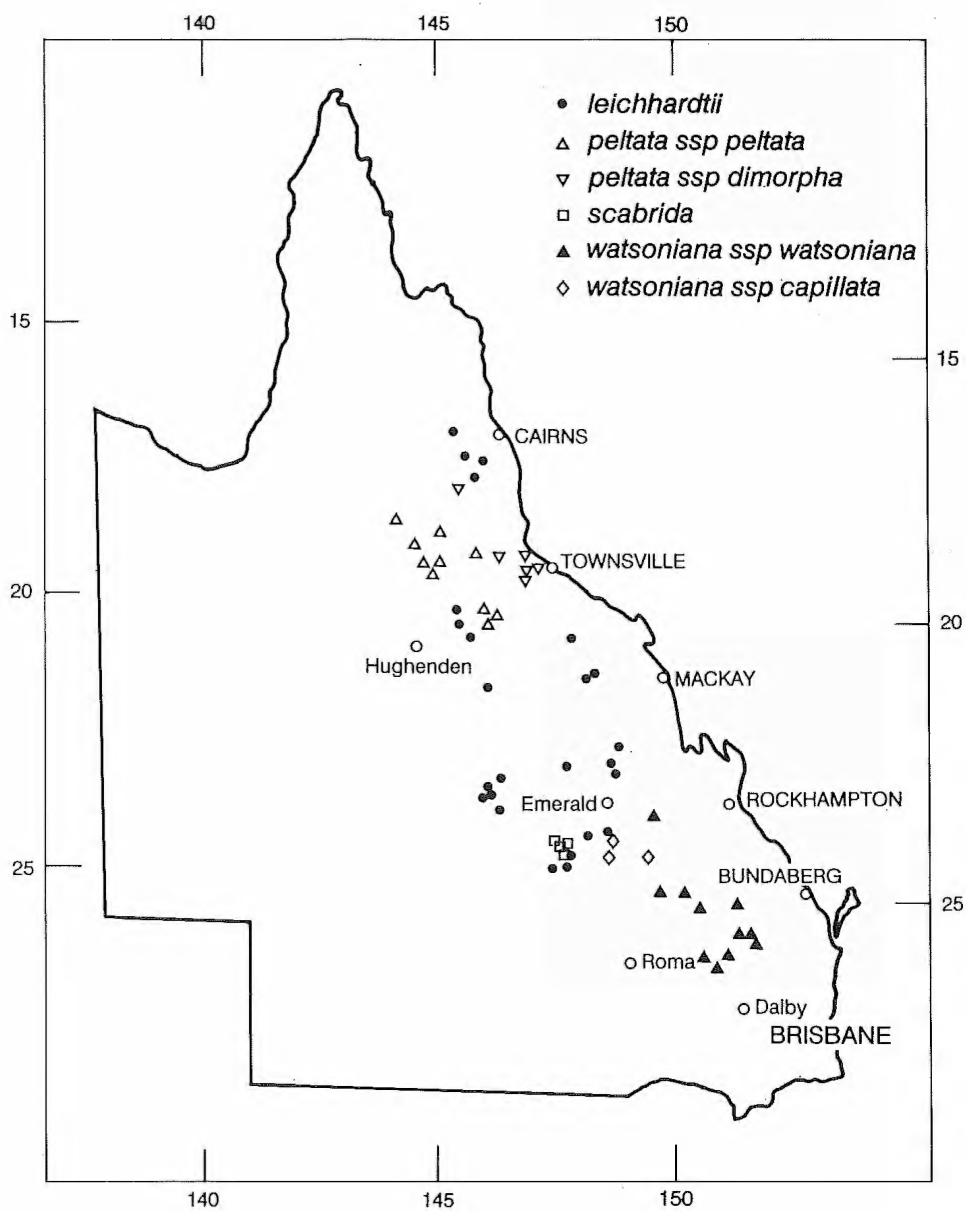


Fig. 8. *E. bunites*: from seedling of Brooker 10224 $\times 0.4$.



Map 1. Distribution of *E. peltata* subsp. *peltata*; *E. peltata* subsp. *dimorpha*; *E. scabrida*; *E. leichhardtii*; *E. watsoniana* subsp. *watsoniana*; *E. watsoniana* subsp. *capillata*.

6. *Eucalyptus eximia* Schauer in W.G. Walpers, Repert. Bot. Syst. 2: 925 (1843). **Type:** New South Wales, Banks of Grose R., 9–10 November 1803, *R. Brown & F. Bauer* s.n. (holo: W; iso: BM,E,K,MEL,NSW).

Tree to 15 m high. Bark brownish yellow, persistent except on small branches. Seedling leaves remaining opposite for three pairs, elliptical, peltate from second pair onwards. Juvenile leaves alternate, concave, very conspicuously peltate, hairs on stems, petioles and leaves short and bristly, to 16×9 cm, grey-green. Adult leaves falcate, to 21×2.8 cm, grey-green, concolorous. Coppice leaves also falcate, but larger, up to 27×5.2 cm, acuminate. Petioles flattened, 15–27 mm long. Peduncles flattened, up to 35 mm long. Unit inflorescences 7-flowered. Pedicels 0–2 mm long. Buds clavate, to 12×9 mm. Operculum rostrate, distinctly umbonate. Fruits ovoid, $14\text{--}18 \times 12\text{--}15$ mm, sessile or very shortly pedicellate. **Fig. 9A & B.**

Specimens examined: New South Wales. Maroota, Dec 1930, *de Beuzeville* 29 (CANB); Cowan, Dec 1931, *de Beuzeville* 374–377 (CANB,NSW); St Albans, towards Wollombi, Feb 1979, *Briggs* 335 (CANB); between Hawkesbury River and Woy Woy, Nov 1970, *Brooker* 2842 (BRI,CANB,MEL); plateau east of Picton Lake, Nov 1974, *Brooker* 4616 (BRI,CANB,MEL,NSW); shoulder, N end of Broken Back Range, WNW of Pokolbin, Jun 1976, *Brooker* 5152 (AD,BRI,CANB,MEL,NSW); Howe's Mtn, Aug 1963, *Burgess* (seed 631931) (CANB,CBG); near Mitchell Pass lookout, Blue Mtns ascent, Apr 1962, *Burgess* (seed 62889) (CANB,CBG); Emu Plains, Jan 1900, *Cabbage* (CANB); Sawyer's Gully, Maitland, Dec 1901, *Cabbage* (CANB); Blaxland Park, Blaxland, Apr 1975, *Chippendale* 1194 & *Brennan* (AD,BRI,CANB,MEL,NSW,PERTH); Hawkin's Lookout near Wiseman's Ferry, Sep 1984, *Coveny* 11907 (CANB,NSW); 83 miles [138 km] from Windsor, May 1968, *Dunlop* 115 (CANB,CBG); Luddenham, Feb 1968, *Hall* (CANB); Glenbrook RAAF Station, Nov 1965, *Johnston & Vos* (CANB); 1.9 km W of Warrimoo towards Springwood, Jul 1974, *Kleinig* 133 (CANB); between Colo Heights and Colo River, Sep 1966, *Phillips* (CANB,CBG); Yalwal road, Aug 1988, *Slee* 2253* (BRI,CANB,NSW); Putty road, Oct 1988, *Slee* 2363* (BRI,CANB,NSW);

Distribution and habitat: *E. eximia* is endemic in New South Wales and extends from Pokolbin to Nowra (**Map 2**). It is most common around Sydney and the lower Blue Mountains, growing on shallow sandy soils on the Hawkesbury sandstone. It grows with *E. gummifera* (Gaertner) Hochr., *E. punctata* DC. and *Angophora costata* (Gaertner) Britten.

Flowering period: September – November.

Notes: *E. eximia* is quite disjunct from other members of series *Naviculares*. It is notable for the large curved adult leaves, broad juvenile leaves peltate for many nodes and the relatively large fruit.

7. *Eucalyptus watsoniana* F. Muell. Fragm. 10: 98 (1876). **Type:** Wigton, Queensland, in 1876, *T.W. Watson* s.n. (holo: MEL; iso: K).

Eucalyptus watsoniana F. Muell. subsp. *watsoniana*

Tree to 18 m high; bark bright orangy yellow to brownish yellow. Seedling leaves remaining opposite for three pairs, hairy. Subsequent leaves alternate, glabrous. Stems and petioles also glabrous beyond this point. Very few or no leaves peltate. Juvenile leaves broadly lanceolate, base obtuse, apex acute, to 22×10 cm, grey-green, concolorous. Adult leaves lanceolate, $14\text{--}18 \times 2.5\text{--}4.5$ cm, grey-green, concolorous. Petioles to 27 mm long, flattened. Peduncles angular or terete, to 28 mm long. Unit inflorescences 7-flowered. Pedicels to 12 mm long. Buds to 19×16 mm, operculum flat, umbonate, broader than hypanthium. Fruits ovoid to urceolate, $21\text{--}32 \times 18\text{--}24$ mm, pedicels 5–14 mm long. **Figs 2B, 9C & D.**

Selected specimens. Queensland. LEICHHARDT DISTRICT: Isla Gorge, Mar 1990, *Bean* 1426* (BRI,CANB); 55 km from Taroom-Theodore road towards Glenhaughton, Mar 1982, *Brooker* 7334 (BRI,CANB,NSW); 38 miles [62 km] N of Taroom towards Theodore, Apr 1975, *Brooker* 4801 (BRI,CANB); 40 km SSE of Theodore, vicinity of Isla Gorge, Jan 1977, *Guymer* 863 (CANB,NE); c. 11 km N of "Jameroo" Station, N of Taroom, May 1976, *Martensz* 975 (BRI,CANB,MEL,NSW); 60 km W of Theodore, Aug 1976, *Martensz* 1001 (BRI,CANB); 4.5 km S of Fairyland, S of Cracow, May 1985, *Brooker* 9000* (CANB). BURNETT DISTRICT: Auburn Range, S of "Rockybar", Mar 1990, *Bean* 1429* (BRI,CANB); Portion 7, Parish of Chesborough, 18 road miles [29 km] from Mundubbera, Aug 1971, *Brooker* 3757, 3758 (BRI,CANB,NSW). DARLING DOWNS DISTRICT: Barakula, Apr 1975, *Brooker* 4779 (AD,BRI,CANB,MEL,NSW); Ballon S.F., Jun 1959, *Johnson* [NSW 132493] (CANB,NSW); north of Jandowae on road to Fairyland, Sep 1970, *Hall* s.n. (CANB); 9.3 km N of Barakula Forest Office, Sep 1974, *Chippendale* 1082 (BRI,CANB).

Distribution and habitat: This taxon occurs in southern Queensland (**Map 1**). The type locality, Wigton, is at the eastern extremity of its distribution, and it extends west to the Robinson Gorge area and north to the Blackdown Tableland. It grows on sandstone

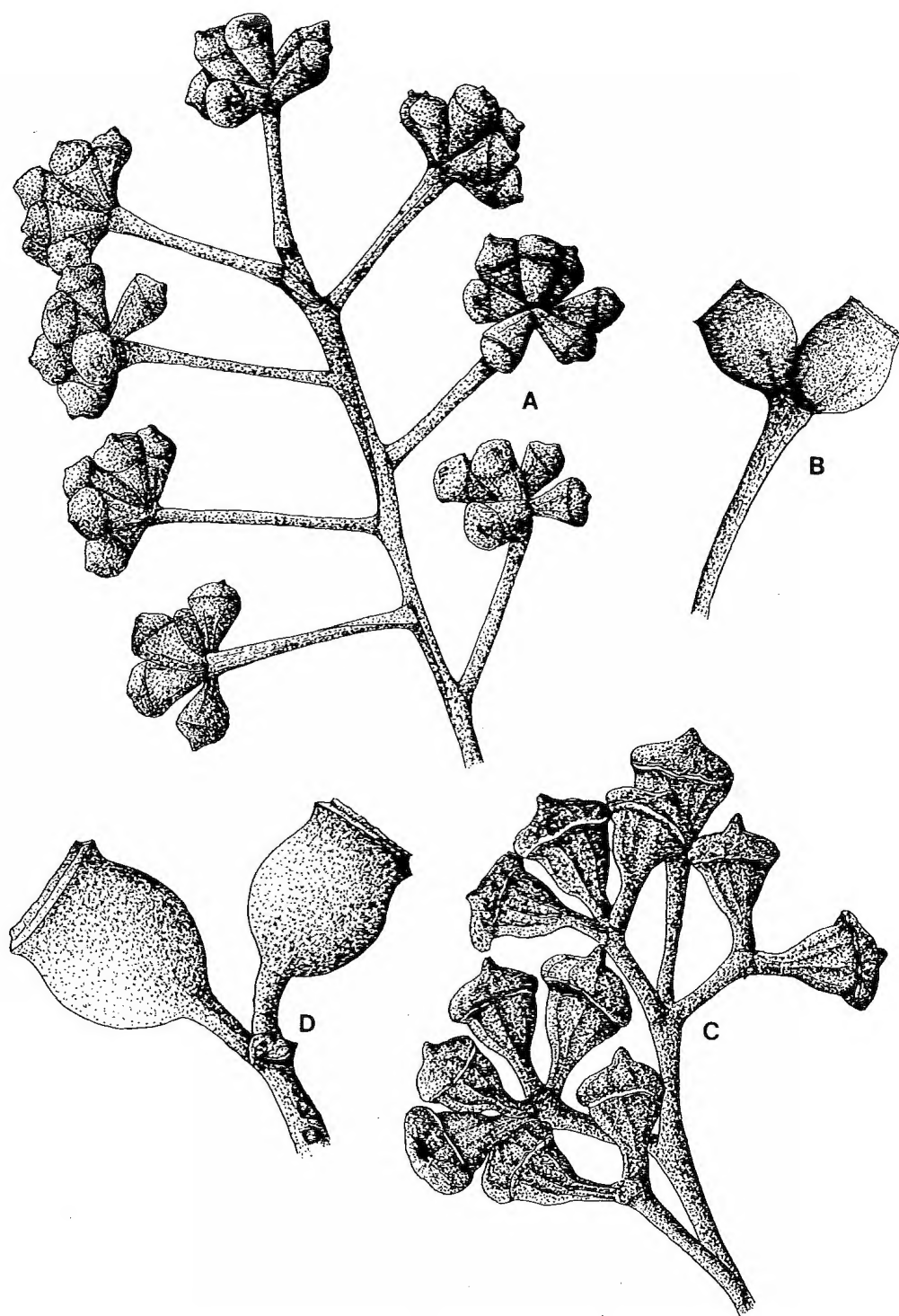


Fig. 9. *E. eximia*: A. buds $\times 1$. B. fruit $\times 1$. *E. watsoniana* subsp. *watsoniana*: C. buds $\times 1$. D. fruit $\times 1$. Subsp. *capillata* differs only slightly in size. A,B, Coveny 11907; C, Martensz 1001; D, Chippendale 1082.

ridges on shallow sandy soils. It is often associated with *E. tenuipes* (Maiden & Blakely) Blakely & C. White, *E. maculata* Hook. and *E. suffulgens* L. Johnson & K. Hill.

Flowering period: June – September.

Notes: *E. watsoniana* subsp. *watsoniana* is characterised by broad, dull adult leaves and few or no peltate seedling leaves. The fruits, which are up to 32 mm long, are the largest found in the series.

8. *Eucalyptus watsoniana* F. Muell. subsp. *capillata* Brooker & A. Bean, subsp. nov. A subspecies typica plantulis pubescentibus, foliis valde peltatis, foliis adultis latioribus, petiolis brevioribus, et fructibus aliquantum parvioribus differt. **Typus:** Queensland. LEICHHARDT DISTRICT: 30.4 miles [50 km] E of Rolleston in Expedition Range, Queensland, 23 April 1975, *M.I.H. Brooker* 4833* (holo: BRI; iso: AD,CANB,MEL,NSW).

Tree to 13 m high, bark yellow to brownish yellow, persistent except on small branches. Seedling leaves remaining opposite for two to about five pairs, first three pairs not peltate; all subsequent leaves markedly peltate; stems and petioles hairy although upper seedling leaves hairy only on major veins. Juvenile leaves concolorous, dull, blue-green, 15–20 × 7–12 cm, leaves becoming glabrous by 10th node; stems hairy to about 15th node. Scabrid, peltate leaves may persist on crown of mature tree. Adult leaves lanceolate to broadly lanceolate, 12–16 × 4.1–6.1 cm, grey-green, concolorous, glabrous, non-peltate. Petioles to 25 mm long, flattened. Peduncles up to 40 mm long, terete or angular. Unit inflorescences 7-flowered. Pedicels 0–6 (9) mm long. Buds 17–20 × 13–15 mm. Operculum broader than hypanthium, apiculate. Fruits ovoid to cylindrical or urceolate, 20–25 × 18–20 mm. **Fig. 9C & D.**

Specimens examined. Queensland. LEICHHARDT DISTRICT: 23.4 km from Springsure towards Rolleston, Apr 1979, *Boland* 1569* (CANB); 61 miles [99 km] south of Emerald (between Springsure and Rolleston), Jul 1968, *Brooker* 1446 (CANB,GAUBA); 14.2 miles [24 km] from Springsure towards Rolleston, Apr 1975, *Brooker* 4829* (AD,BRI,CANB,MEL,NSW); Expedition Range, Dawson Highway, 28 km W of Bauhinia Downs, Mar 1982, *Brooker* 7353 (BRI,CANB,NSW); W of Coynes Bore, Mar 1990, *Brooker* 10447 (CANB); between Bauhinia Downs and Rolleston, Mar 1990, *Brooker* 10448 (CANB); 14 miles [23 km] W of Bauhinia Downs, Aug 1962, *Johnson* 2468 & *Everist* (BRI,CANB); 23 miles [38 km] WSW of Rolleston, Aug 1961, *Lazarides & Story* (CANB); c. 5.5 km W of Coynes Bore road to Mt Ogg on Mt Inglis Holding, Aug 1976, *Martensz* 1084* (CANB); 25 km S of Springsure towards Rolleston, Aug 1975, *W. McCreddie* Tree 12 (CANB).

Distribution and habitat: This subspecies is confined to central Queensland, on the Expedition and Staircase Ranges, east and west of Rolleston respectively (**Map 1**). It grows in shallow sandy soil on sandstone hillsides and ridges. At the northern end of the Staircase Range, there is intergradation between this subspecies and *E. leichhardtii*.

Flowering period: November.

Etymology: From the Latin *capillatus*, hairy, in reference to the seedlings.

Notes: The subspecies is distinguished from *E. watsoniana* subsp. *watsoniana* by its persistent peltate juvenile leaves, somewhat smaller fruits, shorter pedicels and the operculum which is only slightly broader than the hypanthium.

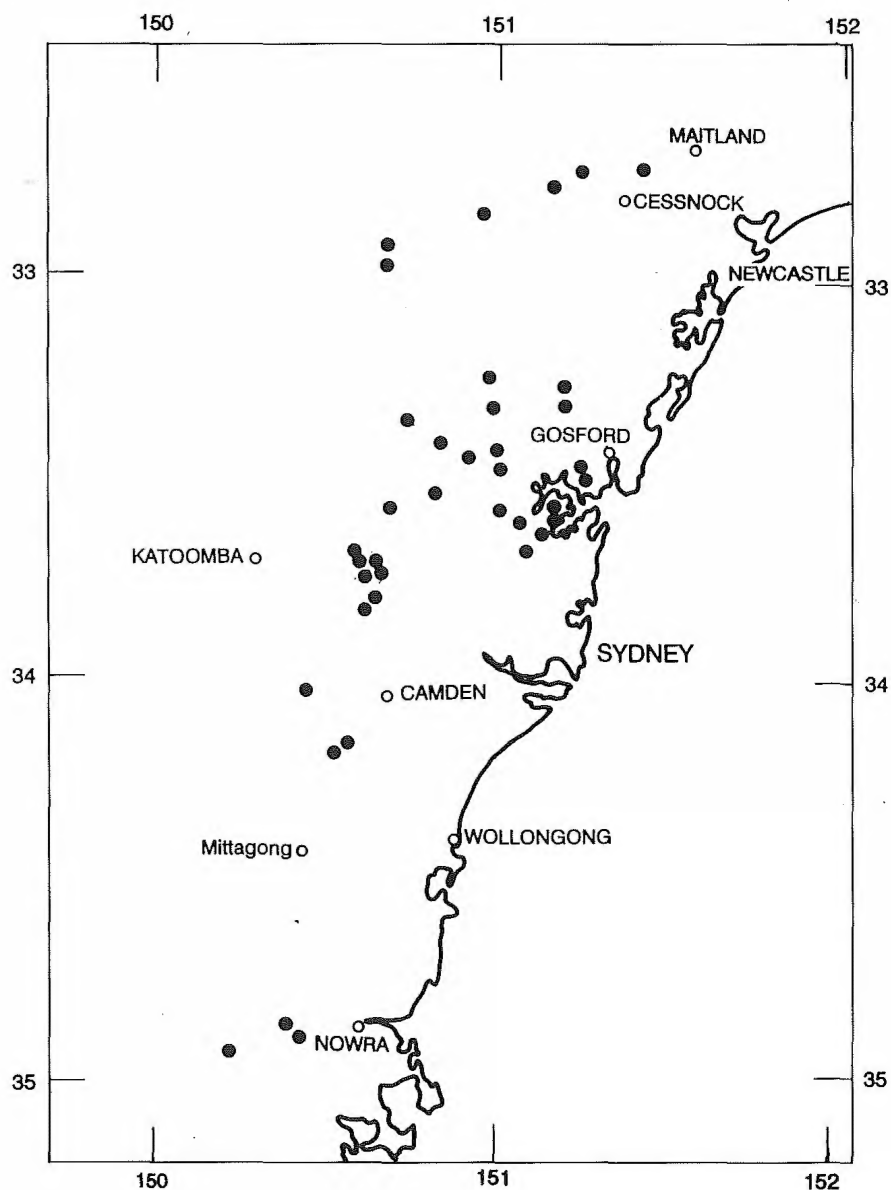
9. *Eucalyptus petalophylla* Brooker & A. Bean, sp. nov. *Eucalypto watsonianae* F. Muell. affinis a qua alabastris parvioribus, operculo latitudinem hypanthii aequanti et fructibus multo parvioribus differt. **Typus:** Queensland. BURNETT DISTRICT: Beeron Holding, 5 km W of "Toondahra" homestead, (25°59'S, 151°21'E), 9 September 1989, *A.R. Bean* 1112 & *P.I. Forster* (holo: BRI, iso: A,DNA,HO,MEL,NSW,PERTH,CANB,QRS).

Tree to 13 m high, often of poor form, bark orangy or orangy brown. Smallest branches smooth. Seedling leaves remaining opposite for three pairs, elliptical, base obtuse or slightly cordate. Leaves, petioles and stems hairy. Next four leaves alternate, peltate, after which all leaves non-peltate. Stems, petioles and laminae glabrous from midway through the peltate stage. Juvenile leaves ovate to broadly lanceolate, concolorous, to 25 × 10 cm, grey-green, petioles to 22 mm long. Adult leaves lanceolate, 15.5–19 × 2.5–4.0 cm, dull grey-green, concolorous. Petioles 20–38 mm long, markedly flattened (up to 2 mm wide). Peduncles to 28 mm long. Unit inflorescences usually 7-flowered, but occasionally up to 21-flowered. Pedicels 1–4 mm long. Buds to 7 × 4 mm, clavate,

operculum low hemispheric with a blunt point, not wider than hypanthium. Fruits ovoid to truncate-spherical, 8–14 × 8–12 mm. Figs 3, 10A & B.

Specimens examined. Queensland, BURNETT DISTRICT: Eidsvold District, *Bancroft* [AQ 131525] (BRI); southern end of "Munboree" Station, SW of Gayndah, Apr 1985, *Bean* 149 (BRI); 20 km W of Eidsvold, Jul 1989, *Bean* 1102, 1104 (BRI); "Munboree" Station, via Gayndah, Oct 1987, *Brooker* 9763*, 9764, 9765 (BRI, CANB); Mt Lorna Summit, 3.5 km W of "Toondahra" homestead, Sep 1985, *Forster* 2238 (BRI); 15 km WSW of Eidsvold, Jul 1981, *Vandersee* [AQ 345766] (BRI).

Distribution and habitat: This species is confined to the Burnett district of south-eastern Queensland (Map 3). There are two known populations, both sizeable, and both growing on skeletal soils derived from granite. Associated species include *E. baileyana* F. Muell., *E. trachyphloia* F. Muell. and *E. watsoniana* F. Muell.



Map 2. Distribution of *E. eximia*.

Flowering period: July – September.

Etymology: From the Greek *petalos*, broad and *phyllon*, leaf, in reference to the large juvenile leaves.

Notes: *E. petalophylla* is unusual in the yellow bloodwoods with its clear disjunction in distribution. It is notable for the short peltate-leaf phase and the relatively large leaves at all stages of growth.

10. Eucalyptus bloxsomei Maiden, J. & Proc. Roy. Soc. New South Wales 59: 156 (1925).

Type: Hippong, Queensland, 1919, April 1922, June 1922, 10 October 1922, February 1923, March 1925, *H.S. Bloxsome* s.n. (syn: BRI (April 1922, March 1925), NSW).

Tree to 22 m tall with bright golden-yellow bark on trunk and most branches. Small branches smooth-barked. Seedling leaves remaining opposite for about four pairs, elliptical, to 42 × 22 mm. Stems, petioles and laminae hairy. A few subsequent leaves (about five) barely peltate, green, ovate to broadly lanceolate, to 14 × 6 cm. Juvenile leaves non-peltate, discolorous, becoming somewhat glossy green, apex acute, base obtuse, a few hairs persisting on stems, petioles and leaf midribs. Adult leaves lanceolate or narrowly lanceolate, to 18 × 3 cm, bright glossy green, concolorous. Petioles flattened, to 25 mm long. Peduncles up to 18 mm long. Unit inflorescences mostly 7-flowered, occasionally up to 11-flowered. Pedicels 3–6 mm long. Buds ovoid, up to 10 × 6 mm. Operculum apiculate or beaked. Hypanthium not glaucous. Fruits ovoid or urceolate, 14–16 × 10–13 mm. **Fig. 10C & D.**

Selected specimens. Queensland. LEICHHARDT DISTRICT: 20 miles [32 km] S of Wandoan, Apr 1964, Speck 1973, 1974 (BRI,CANB). BURNETT DISTRICT: Myola Road, between Wee Wee Creek and Myola, Aug 1985, Bean 265 (BRI); 27.9 miles [44.6 km] from Mundubbera towards Chinchilla, Aug 1972, Brooker 3760 (BRI,CANB,K,NSW); S of Mundubbera on road to Boondooma, Dec 1944, Shaw 5118 (CANB). DARLING DOWNS DISTRICT: Welsh's Road, 5.2 km from Leichhardt Highway, Oct 1987, Brooker 9791* (BRI,CANB); c. 50 km NNE of Chinchilla near Durah homestead, May 1971, Johnson 7089 & Briggs (CANB,NSW); 9.6 km N of Barakula Forest Office, Sep 1974, Chippendale 1081 (CANB); NE of Burncluth, Aug 1968, Brooker 1508, 9 (CANB,GAUBA); Ballon State Forest reserve, Mar 1953, Blake 19170 (BRI,CANB); 3.3 miles [5.3 km] from Fairyland corner on Mundubbera road, S of Ballon, Apr 1975, Brooker 4776* (AD,BRI,CANB,MEL,NSW); 6 km W of turn-off to Chinchilla from intersection N of Jandowae, Mar 1982, Brooker 7311 (BRI,CANB,NSW).

Distribution and habitat: *E. bloxsomei* has a restricted distribution in southern Queensland between Chinchilla and Mundubbera, and centred on the Barakula State Forest (Map 3). It grows in moderate to deep sandy soils in country of low relief. Commonly associated species include *E. chloroclada* (Blakely) L. Johnson & K. Hill, *Angophora leiocarpa* (Johnson ex Leach) Thiele & Ladiges and *E. maculata* Hook.

Flowering period: June – August.

Notes: *E. bloxsomei* is notable for the bright glossy green adult leaves, a character it shares with *E. aureola* and *E. leptoloma* in the yellow bloodwoods. The type locality, Hippong, lies within the Barakula State Forest.

11. Eucalyptus aureola Brooker & A. Bean, **sp. nov.** *Eucalypto bloxsomei* Maiden affinis a qua foliis plantularum peltatis per nodos multos, foliis adultis angustioribus, alabastris glaucis, pedicellis brevioribus et habitatione dissimili differt. **Typus:** Queensland. LEICHHARDT DISTRICT: hills W of Lake Elphinstone, Carborough Range, 20 May 1989, M.I.H. Brooker 10212* (holo: BRI; iso: CANB,NSW).

Tree to 14 m tall, with bright golden-yellow bark on trunk and most branches. Small branches smooth-barked. Seedling leaves remaining opposite or sub-opposite for about ten pairs, broadly ovate. First three or four pairs not peltate; subsequent leaves all peltate, with obtuse or cordate base. Stems, petioles and leaf veins hairy. Juvenile leaves alternate, lanceolate, to 28 × 7 cm, glossy-green on upper surface. Adult leaves narrowly lanceolate or falcate, up to 18 × 2.4 cm, bright green, concolorous. Petioles terete or flattened, up to 25 mm long. Peduncles to 17 mm long. Unit inflorescences 7-flowered. Pedicels 0–2 mm long. Buds clavate, to 11 × 7 mm, often glaucous. Operculum low hemispheric. Fruits ovoid, cylindrical or urceolate, 14–18 × 11–16 mm. **Fig. 10E & F.**

Specimens examined. Queensland. LEICHHARDT DISTRICT: Hills beside Lake Elphinstone, Jun 1989, Bean 1043 (BRI); 84 km E of Clermont towards Mackay, Jul 1976, Brooker 5329*, 5330* (CANB); 0.5 km S of Lake Elphinstone in the Carborough Range, Aug 1976, Martensz 1096* (BRI,CANB); Cherwell Range, Aug 1986, Bean 502 (BRI,CANB).

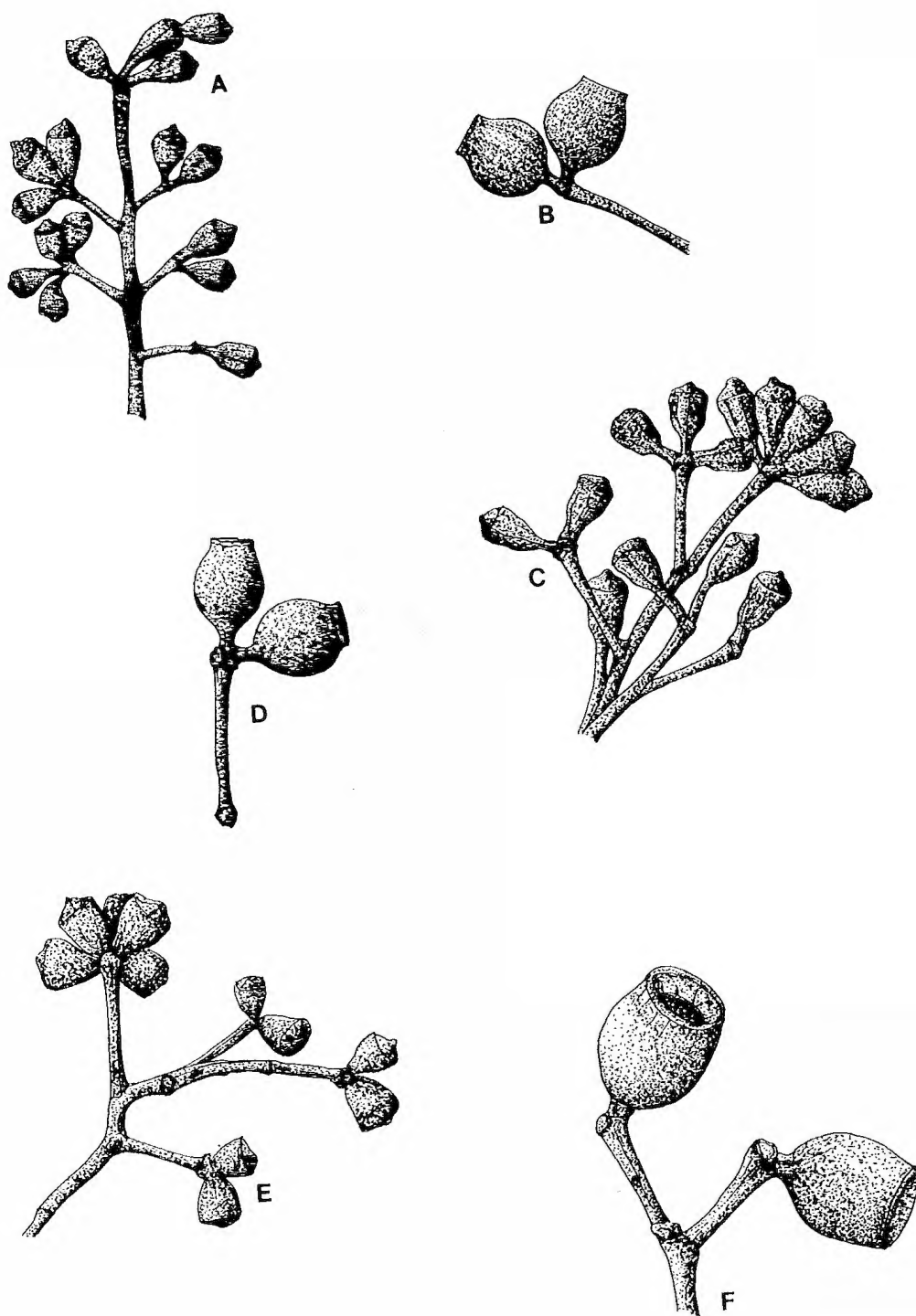


Fig. 10. *E. petalophylla*: A. buds $\times 1$. B. fruit $\times 1$. *E. bloxsomei*: C. buds $\times 1$. D. fruit $\times 1$. *E. aureola*: E. buds $\times 1$. F. fruit $\times 1$. A, Brooker 9765; B, Brooker 9763; C,D, Brooker 9791; E, Bean 502; F, Brooker 5330.

Distribution and habitat: This species has a restricted distribution in central Queensland, on the Cherwell Range, south of Moranbah and the Carborough Range, west of Nebo (Map 3). It grows on sandstone ridges on skeletal soils, and is associated commonly with *Acacia shirleyi* Maiden, *E. trachyphloia* F. Muell. and *E. papuana* F. Muell.

Flowering period: Unknown.

Etymology: From the Latin *aureolus*, golden, in reference to the bark.

Notes: *E. aureola* is most notable for the juvenile leaves which are long, narrow, peltate and glossy and resemble no other species in the series. The bark is strikingly golden-yellow.

12. *Eucalyptus leptoloma* Brooker & A. Bean, **sp. nov.** *Eucalypto bloxsomei* Maiden affinis a qua foliis plantularum valde peltatis, latis, nitentissimis, foliis adultis nitentibus valde discoloribus, alabastris brevioribus glaucis et fructibus brevioribus differt. **Typus:** Queensland. NORTH KENNEDY DISTRICT: c. 12 km W of Paluma, Queensland, 19 May 1989, *M.I.H. Brooker* 10207* (holo: BRI; iso: CANB, DNA, MEL, NSW).

Tree to 18 m tall, with erect trunk. Bark yellow or brownish yellow, persistent right to twigs. Seedling leaves remaining opposite for four or five pairs, third, fourth and fifth pair cordate and deeply dissected at base to point of petiole attachment, sixth and seventh pair slightly peltate. Stems, petioles and leaves hairy to about 6th pair, then glabrous apart from underside of midrib. Juvenile leaves alternate, peltate, broadly lanceolate, to 20 × 12 cm, glossy green, discolorous. Adult leaves lanceolate, to 14 × 4.1 cm, markedly discolorous with margins rolled under, dark glossy green on upper surface. Petioles 15–22 mm long, flattened. Peduncles up to 15 mm long. Unit inflorescences 7-flowered. Pedicels 1–3 mm long. Buds clavate, glaucous, 6–7 × 4.5–6 mm. Operculum conical. Fruits truncate-spherical, 8–9.5 × 8–9 mm. **Figs 11 & 12.**

Specimens examined. Queensland. NORTH KENNEDY DISTRICT: Towards Hidden Valley, 13.9 km W of Paluma, Jun 1989, *Bean* 1059* (BRI); 14 km W of Paluma, Mar 1990, *Brooker* 10407*, 10408*, 10409* (BRI, CANB, MEL, NSW); 8 km E of Hidden Valley on Paluma road, Aug 1984, *Hill* 1158 (NSW).

Distribution and habitat: *E. leptoloma* is a rare species known only from the Paluma-Hidden Valley road (Map 3), where it occurs near watercourses along a 2 km band. The riverine soil is white and coarsely sandy but on adjacent slopes, the species grows in shallow, sandy soil between outcropping granite. It is associated with *Syncarpia glomulifera* (Smith) Niedenzu, *E. resinifera* Smith, *E. acmenoides* Schauer, and *Casuarina torulosa* Aiton.

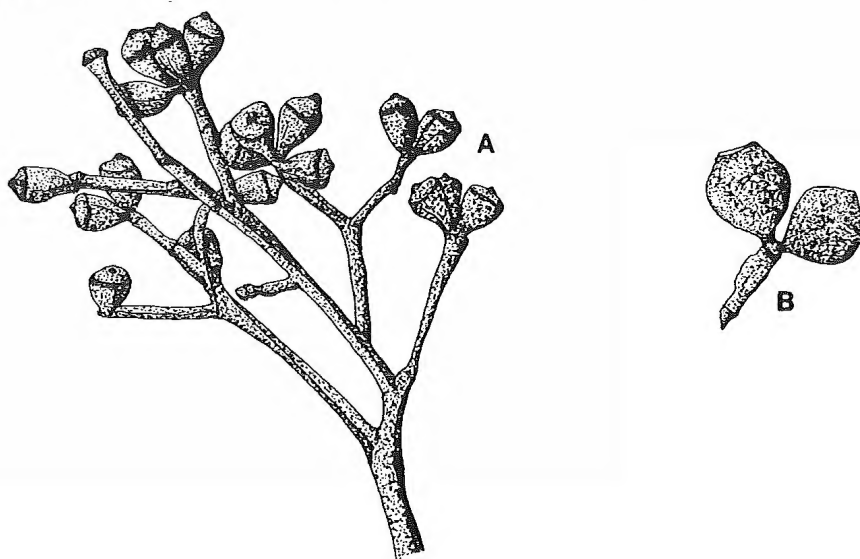


Fig. 11. *E. leptoloma*: A. buds × 1. B. fruit × 1. A, B, Brooker 10207.

Flowering period: Unknown.

Etymology: From the Greek *lepto*, narrow and *loma*, border, in reference to the slightly downturned edges of the adult leaves.

Notes: *E. leptoloma* has the tallest trees of any species in the series (possibly equalled by those of *E. bunites* and *E. bloxsomei*). It is unique in the series with its discolorous adult leaves that exhibit the minutely down-turned edges characteristic of other eucalypt species with discolorous leaves. The deeply cordate seedling leaves and subsequent broad, glossy, juvenile leaves are also distinctive. It is the only yellow bloodwood with rough bark to the twigs.

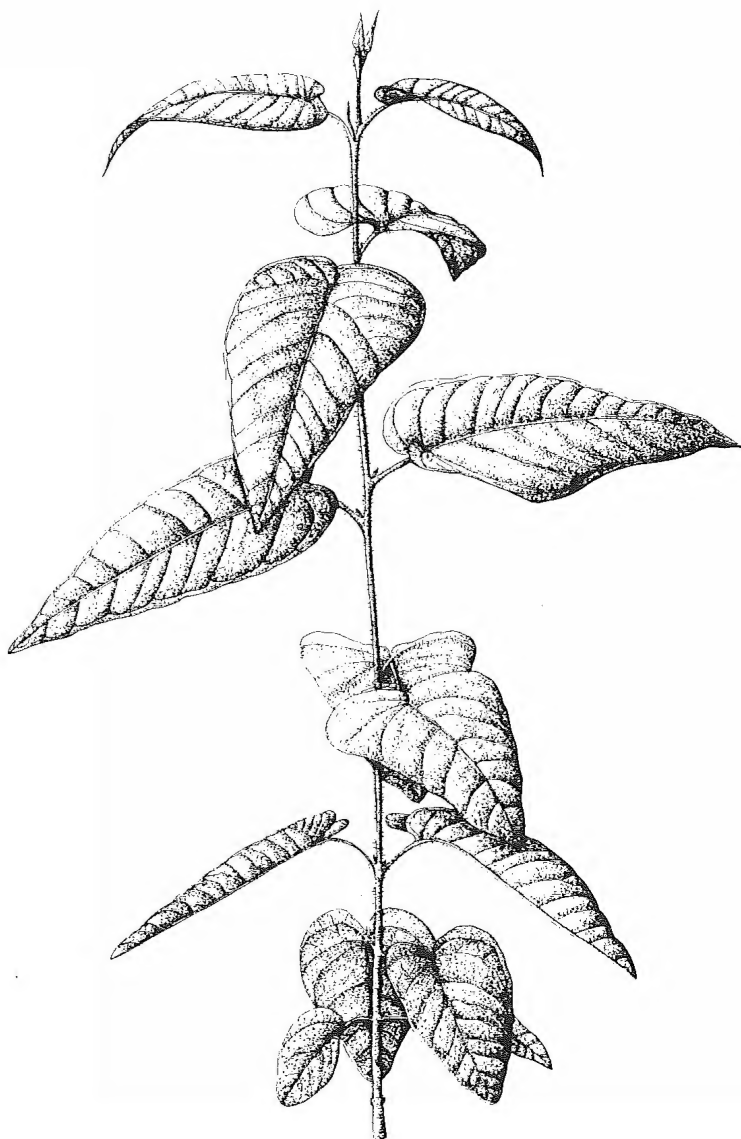


Fig. 12. *E. leptoloma*: from seedling of Brooker 10207 $\times 0.4$.

8. Phytogeography and species concepts

Because of its proximity to long-settled and highly populated areas of the central coast of New South Wales, the distribution of *E. eximia* is better known than that of the other yellow bloodwoods. Of more biological significance is its isolation by more than 600 km from its nearest congener, *E. bloxsomei*. Despite this disjunction, there appears to be no exceptional morphological divergence which would isolate it within the series. This may reflect the resistance to genetic modification from potential introgressing species such as other bloodwoods (*E. gummifera*, *E. maculata*), the stability of the environment or relatively recent disjunction.

The remainder of the species, all endemic in Queensland, occur often fragmented within their own distributional range over a north-south distance of about 1200 km and east-west distance of about 350 km. Because of the relative inaccessibility of much of this area, we have been unable to ascertain distributions of any taxon with accuracy comparable to that of *E. eximia*.

Broad-scale depictions of distribution as given in the conventional maps may conceal true biological disjunctions across which gene exchange is prevented. Nevertheless, we are satisfied with the morphological integrity of all the taxa we have treated and are not aware of any interspecific hybrids within series *Naviculares* despite sympatry in some areas. Intraspecific variation occurs, although coherence in the diagnostic characters at the species level is strong.

The least variable species in the series are *E. bloxsomei* and *E. scabrida*. This may reflect their relatively compact distributions across which gene exchange is active. *E. watsoniana*, which is partly sympatric with *E. bloxsomei*, is of much greater and probably sparser distribution than these species. The northern and southern forms of this species are clearly divergent in the juvenile phase while convergent in the adult. We recognise this phenomenon in the erection of subspecies.

E. bunites is another species with recognizably different juvenile forms at the ends of its known geographical range, but we consider the leaf colour distinction to be minor compared with the extremes of peltation and pubescence seen within *E. watsoniana*. Because of the wide distribution of *E. watsoniana* and the often inaccessible terrain where *E. bunites* occurs, we are unable to collect comprehensively along a transect to test further the patterns of morphological variation in relation to distribution for these two species. Perhaps further exploration will show *E. bunites* to be truly disjunct in its distribution.

It is likely that *E. bunites* is the most modified of the yellow bloodwoods because of its narrow juvenile leaves, the complete loss of peltation, the smallness of the buds and fruit and the extremely rare condition of reduced ovule row number. The species occurs towards the middle of the range of the Queensland yellow bloodwoods and is possibly sympatric with *E. watsoniana* subsp. *capillata*. In its Blackdown Tableland occurrence, *E. bunites* attains with *E. leptoloma* the highest altitude of occurrence recorded for species in series *Naviculares* (c. 900 m).

While distributions are imperfectly known, we are satisfied that *E. aureola*, through its apparent geographic isolation, is allopatric to all other yellow bloodwoods. This may be the case with *E. peltata* subsp. *dimorpha*, although it occurs close to *E. leichhardtii* and *E. peltata* subsp. *peltata* west of Townsville. *E. leptoloma* occurs within the distribution of *E. leichhardtii* in this area. The two species appear to be parapatric with the taller, green-leaved *E. leptoloma* occurring to the east of the smaller, slightly bluish-leaved *E. leichhardtii* and separated by less than 1 km.

At the eastern part of its very limited distribution, *E. leptoloma* occurs close to a tall stand of *E. grandis* west of the town of Paluma, north Queensland, which has an annual rainfall of 2685 mm. *E. leptoloma* is the only yellow bloodwood with discoloured adult leaves, a characteristic of *E. grandis* (series *Transversae* Blakely) and many other eucalypts of high rainfall areas. The other yellow bloodwoods have concolorous adult leaves and occur in drier sites.

The clearest intra-species disjunctions are in *E. petalophylla*, which is known from only two small occurrences, viz west of Eidsvold and south of Mundubbera, approximately 60 km apart, and in *E. leichhardtii*, which is the most widespread yellow bloodwood,

occurring from north-west of Mareeba, north Queensland, south to the Salvator Rosa National Park, central Queensland, while appearing to be completely absent from the lower parts of the Burdekin River catchment.

The most striking morphological feature in both the red and the yellow bloodwoods, and exclusive to them, is peltation of the seedling and juvenile leaves. This character has obviously been retained in both groups following their initial divergence. In the yellow bloodwoods peltation occurs in all but two taxa, *E. bunites* and *E. watsoniana*.

Two taxa, *E. peltata* subsp. *peltata* and *E. scabrida* are neotenous while *E. peltata* subsp. *dimorpha* shows some ontogenetic development such that a reproductively mature tree has a crown of mixed juvenile, intermediate and adult leaves. These three taxa are in complete geographic isolation from each other and may have evolved as vicariants from relatively uniform ancestral juvenile stock. In all other species, healthy crowns are composed of adult leaves.

Throughout the genus *Eucalyptus* there are numerous examples of related species which differ, among other characters in the reproductively mature plant, by the juvenile/adult crown phenomenon. The juvenile crown in the mature plant may be a case of arrested ontogeny of no adaptive significance.

An alternative possibility is that the juvenile crown was secondarily imposed as a means of survival during prolonged aridity which caused the inevitable loss of or prevented the ultimate development of adult leaves. Any plants in such a stressed population that were reproductively mature in the juvenile phase were likely to have been strongly selected for.

We have not observed interspecific hybrids in the yellow bloodwoods, but hybrid combinations in areas of sympatry may be expected. In possible cases, e.g. *E. bloxsomei* × *E. watsoniana* subsp. *watsoniana* and *E. petalophylla* × *E. watsoniana* subsp. *watsoniana* (north-western occurrence), individual hybrid trees may be difficult to detect by superficial observation. Seedling comparisons would be of little use between these species pairs, as *E. petalophylla* and *E. watsoniana* subsp. *watsoniana* have somewhat similar seedlings and intermediates between *E. watsoniana*, a taxon with few or no peltate seedlings leaves, and *E. bloxsomei* with few, would provide a very fine distinction. The species of these pairs are distinguished largely by adult characters and hybrids may only be detectable by morphometric analyses. Recognition of hybridism between closely related and, by implication, morphologically similar species is always difficult.

In contrast, hybridism between highly dissimilar species is relatively easy to recognize. This occurs in the bloodwoods between Springsure and Rolleston where *E. citriodora* and *E. watsoniana* subsp. *capillata* grow together and hybridize (Brooker 4830, CANB). The cross between the smooth-barked and the rough-barked species produces individuals that are 1/2 rough-barked. Of more significance is the fact that *E. citriodora* carries the most distinctive genetic marker of all eucalypts. This is the presence of the lemon-smelling citronellal in the essential oils, which occurs in detectable (by crushing the leaves and smelling) quantities only in this species. The leaves of the hybrid also contain easily detectable citronellal. This is a rare example of an interseries cross in the bloodwoods, only reported once before for a cross between *E. gummifera* and *E. maculata* (Griffin *et al.* 1988).

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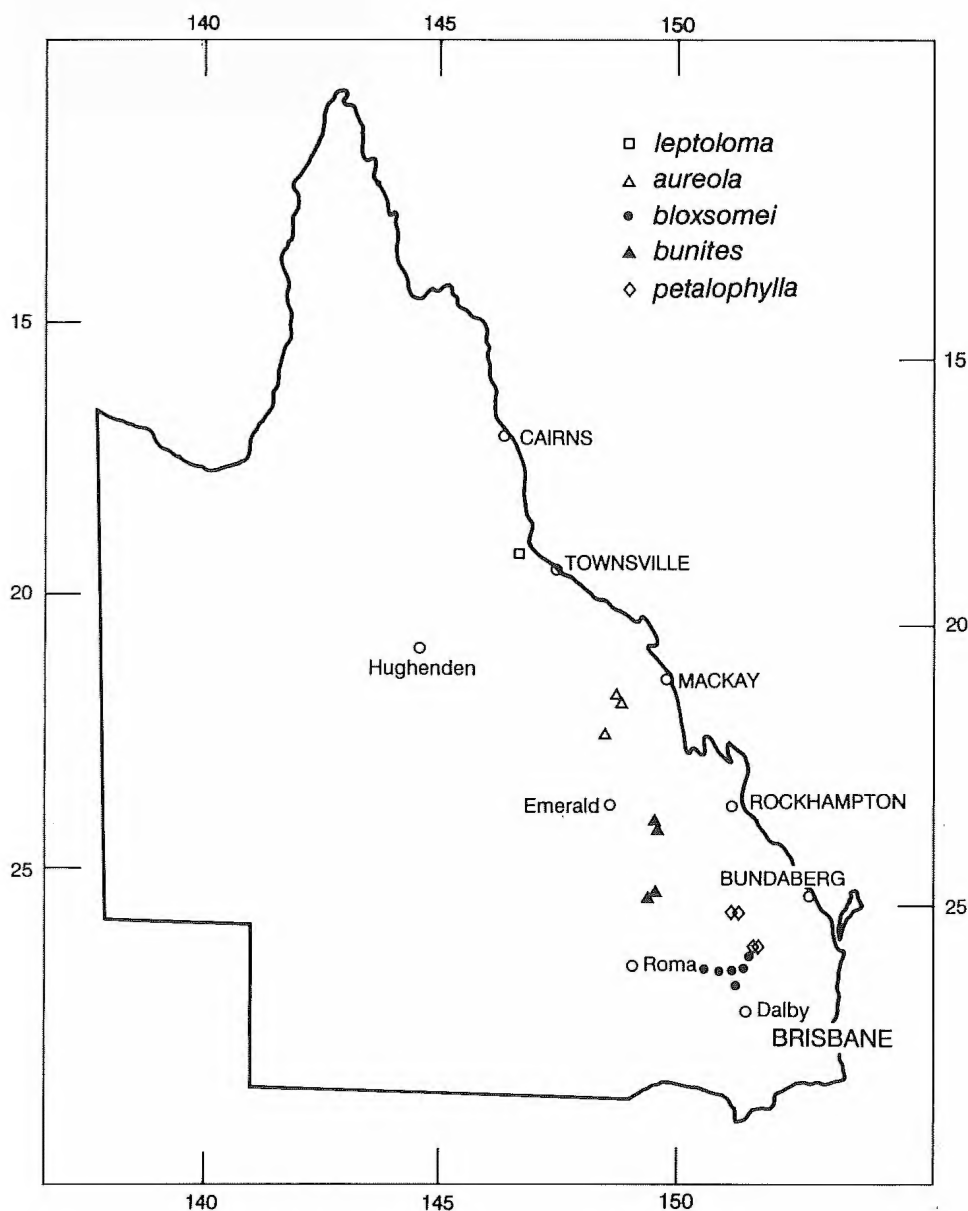
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Map 3. Distribution of *E. petalophylla*; *E. bloxsomei*; *E. aureola*; *E. leptoloma*; *E. bunites*.

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